EDITORIAL

THIS month marks the completion of the concrete sea-wall along San Francisco's waterfront. It extends from Fisherman's Wharf to China Basin and has been under construction nearly twenty years.

SUGGESTION has been made that one of the reasons for the early fall of the fortifications at Antwerp and Namur was the poor quality of steel, concrete, and stone work. This, of course, is not impossible, but we are under the impression that 42-centimetre shells also had something to do with it.

FORTUNATELY the California legislature has not passed the bill introduced by the Independent Oil Producers Agency classing petroleum production as a public utility and placing it under the jurisdiction of the California Railroad Commission. All will agree that waste of any natural resource is bad and that corrective measures of some sort should be undertaken to prevent this waste. It is doubtful, however, whether the passage of this bill would have been of any real help in accomplishing this purpose while its provisions were of so radical a nature as to have shocked even the California legislature.

OIL operators generally will be pleased at the passage by the State Legislature of the Maddux bill providing for state control of protective measures against water infiltration in the California oilfield. While the bill at present writing has not received the Governor's signature, there seems to be little doubt that executive approval will be forthcoming. Doubtless minor defects will develop in the bill as it is put into operation. On the whole, however, it is an excellent and constructive measure and congratulations are due to Mr. F. McM. Hamilton, State Mineralogist, Mr. R. P. McLaughlin and others to whose hard work and careful investigation this result is due.

OCCASIONALLY the state legislature of California does defeat a bill extending its own power and jurisdiction. All of the bills that have been introduced providing for a greater or less degree of state control over county highways have been defeated either on the floor or have succumbed in the committee rooms. There are many excellent reasons why centralization of control of county highway construction would be an excellent thing, but on the other hand the opposition of county supervisors, backed by their political influence, proved too strong for such mere technical advantages as standardization of road surfaces, better engineering, and a more comprehensive knowledge of the subject. It is doubtful whether this question will be revived for at least two years.

FLAT rates as a basis of payment for public necessities are fast disappearing. It is as rational to pay for electric energy by the kilowatt hour as for flour by the pound. Makers of water rates, or rather payers of water rates in many localities, are still possessed of the idea that water ought to be as free as air, and as a commodity that is automatically renewed each year through the bounty of nature, should be subject to the old-time flat rate without restriction as to the quantity used or the quantity wasted. This question in a more concrete form is to come before the voters of Portland, Oregon, and there is decided opposition to the increased use of water-meters. It is hoped that an intelligent viewpoint may prevail over the selfish one and that the wisdom of conserving domestic water-supply as well as other commodities will receive ratification at the polls.

TEMPORARY construction in most cases is a forerunner of permanent loss. The tunnel fire and the cave-in that followed near Tehachapi, California, affords a fresh example. This tunnel is only 350 feet long, nevertheless under present conditions it is necessary for the traffic department of the Southern Pacific Company to run stub trains to each end of the tunnel, discharge passengers and transfer them and their baggage around the tunnel in automobiles. This serious interruption to traffic will continue for several weeks and, as it happens, affects the line of the Southern Pacific Company between Bakersfield and Mojave over which probably the greatest number of train movements take place of any single-track mountain road in the United States. A similar tunnel fire that occurred some two years ago near Santa Margarita resulted in equally serious delays upon the Southern Pacific Company's coast route. Where lines are of so much importance as these, concrete tunnel-lining would make danger from fire a negligible hazard.

IMPERIALISTIC tendencies of the city of Los Angeles have been demonstrated again through the action of the voters of that thriving metropolis on May 4 whereby the San Fernando valley has been annexed to the city. It is interesting to note that this brings the total area within the city limits to 279 square miles, which by the way is only 7 miles smaller than that of New York, the largest American city in area as well as population. New York must look to its laurels as Los Angeles, hav-

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ing reached the limit of western expansion by the natural boundary of the Pacific ocean, is now progressing toward the eastward and the advance guard of the noble army of boosters may soon be heard from in the vicinity of the Nevada and Arizona state lines.

AN interesting side-light upon the situation with respect to the annexation of the San Fernando valley is brought out by the fact that the granting of a water-right to dry land increases its value by anywhere from $200 to $400 per acre. The San Fernando valley has a total acreage of approximately 120,000 and by becoming part of the Los Angeles municipality has a right equal to that of any other section of the city to the waters of the Los Angeles aqueduct. These facts were pointed out by Mr. F. C. Finkle in a communication addressed to one of the Los Angeles daily newspapers and published on May 1. The boom was in the air, however, and Mr. Finkle's admonitions were not heeded. It is interesting to find a verification of Mr. Finkle's statements through the reprinting and distribution of his communication, which is now being circulated throughout the broad land by real-estate promoters, thus indicating the admitted value of the Los Angeles aqueduct as an irrigation scheme without regard to the potability of the water for domestic purposes. The aqueduct pot still sizzles. We look forward to the day when the lid will be off in earnest as we, in common with many others, will be much interested in inspecting the contents.

CALIFORNIA will have an opportunity in November, 1916 to vote for an additional bond issue of $15,000,000 for extensions to the state highway system. A bill to this effect has been authorized by the state legislature and provides funds for completion of the trunk highways as well as sundry laterals and cross highways for the purpose of connecting the main coast and valley routes. Perhaps it is just as well to delay bringing the matter to an issue until November, 1916, rather than at the present time. Since money has been scarce and times hard, the voters have manifested a decided tendency to vote down anything and everything that might result in an increase of taxation. It is to be hoped that by November, 1916, the War will be a thing of the past and that business in the United States will have recovered to such an extent that the additional bond issue for this purpose may be approved. In the meantime the issue under which the present work is being carried on will provide sufficient funds for such work as has been already laid out and until additional funds are required.

Railroad Companies and Automobile Competition

Good roads may be a blessing, but we are inclined to doubt whether the common carriers of one kind or another regard them altogether as such. In the palmy days of mud, dust, and ruts, the only way whereby one could travel over any considerable distance with comfort was by rail. With the advent of good roads, however, came the automobile stage, substituting gasoline for the horse. This method of transportation has developed at many points in the interior so that not only the local steam road traffic but interurban trolleys have experienced severe losses in revenue through the persistence and severity of this type of competition. The Sierra Railway, which for many years has been running from Oakdale to Tuolumne, California, through a more or less mountainous district, is the latest victim of gasoline. Two automobile stage-lines are now operating over this route and incidentally are not only making as good or better time than the steam trains, but are also taking the cream of the passenger business. In common with other steam and electric lines, the railroad company in search for relief has told its troubles to the Railroad Commission. The jitney, as a more or less legitimate child of the automobile stage-lines, has performed a similar operation upon the revenues of the city car-lines. Drastic legislation regulating this new form of transportation is being considered in many states, while an ordinance passed by the supervisors of San Francisco which went into effect in May withholds the granting of a license to jitney drivers except upon filing a $10,000 indemnity bond and increases the cost of the license to a point that will undoubtedly diminish the jitney-bus business to a marked degree. A company has recently purchased a number of auto-buses and is making a bid for the passenger traffic between San Francisco and San Mateo. The state highway, over which they will operate, is undoubtedly one of the finest pieces of road in the state of California. This road surface is so perfect as to be almost monotonous and the buses will make nearly as good time as the steam railroad. The enormous increase of this type of traffic, however, may well be viewed with alarm, not only by the highway engineering department but also by the taxpayers who face the prospect of a great increase in the cost of maintenance for the roads, to say nothing of the possibility that these selfsame roads will be worn out and have to be replaced long before the maturity of the bonds. As we have said before, our sympathies in this case lie entirely with the transportation companies who have expended large sums of money upon rights of way and rolling stock, while the jitney or auto-bus owner is conducting his business over roads which the entire people of the state have unwittingly provided.

City Engineers and Municipal Contracts

Competition may be the life of trade, but unfortunately it often signifies the death of profit. The impression is prevalent among those who do not know that municipal contracting is exceedingly profitable. Perhaps it was in the so-called 'good' old days when graft was the rule and the contractor who was so fortunate as to be on the inside of the ring was generally able to

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get a sufficient advantage over his competitors in one form or another to insure large profits. This is no longer the case, while during the last few years work has been so scarce that the award of a municipal contract has all too frequently been succeeded by a journey through the bankruptcy court.

Now the California legislature has passed a bill permitting city engineers to bid against contractors for municipal work. There is no real objection to this, provided of course that the city engineers are placed upon the same basis as the contractors. This latter we fear is impossible for the reason that the city engineer as a hired man does not have to pay for his mistakes. Then too, engineers' estimates in most cases neglect the important item of overhead charges which must always enter into any contractor's calculations. Our system of government is such that it is extremely difficult to fix responsibility for the mistakes due to under-estimating the cost of the work. While the penalty for many such mistakes might result in the city engineer losing his position, at the same time the public would have to pay the bill. Costs in large organizations are frequently merely a matter of bookkeeping. A surplus appropriation in one department may be diverted to take care of a deficit in another department and the public is none the wiser. It is not difficult to cover up errors in estimating made by city engineers, except when perhaps some enterprising newspaper reporter with a Sherlock Holmes instinct turns on the searchlight of investigation. We cannot see but that municipalities will have everything to lose and nothing to gain by taking advantage of the permission recently granted by the state legislature to compete with their own taxpayers.

The San Francisco Water-Supply Problem

Since the defeat at the polls on April 20 last of the proposal to purchase most of the property of the Spring Valley Water Company for $34,500,000, the question as to the next best line of procedure has commanded considerable attention in San Francisco. The Commonwealth Club of California at a meeting held May 12 considered this question under the general title of 'The Bay-Cities' Water-Supply—What Shall We Do About It Now?' Mr. M. M. O'Shaughnessy, city engineer of San Francisco, discussed the question from the standpoint of those who had favored the purchase of the Spring Valley properties. Mr. Andrew J. Gallagher, member of the board of supervisors and labor-union leader, presented the point of view of those who had opposed the measure. Mr. John D. Galloway, consulting engineer, enacted the role of disinterested third party, or 'innocent bystander.'

Mr. Gallagher expressed his belief that the first step to be taken was providing for the needs of those parts of the city at present suffering from an insufficient water-supply. Additional mains should be laid in these districts. To provide the necessary water, two courses are open, either to sink wells or to arrange with the water company to sell the water to the City and the latter to arrange for its distribution. If the well-water should prove to be of poor quality, it should be filtered. Mains should not only be laid in those parts of the outlying districts already built up but also in sections where development has heretofore been impossible because of lack of water. While such a course would be particularly advantageous to real-estate operators interested in these districts, it should also be remembered that the entire community will be benefited by the development of these sections.

After providing for these pressing needs, the next step is to build the Hetch Hetchy system as rapidly as possible, consistent with good construction. Past experience in San Francisco has shown the disadvantages resulting when the period of construction of some municipal project extended over several city administrations. It is to be hoped that most of the work can be done during the four-year term of the administration to be elected this Fall, and the whole project completed within five or six years. A commission should be appointed to take charge of the work, which should be done, if possible, under the direct charge of the commission, instead of letting it by contract. Steps should be taken to obtain the co-operation of the East Bay and Peninsula communities.

The Railroad Commission should be asked to appraise the property of the Spring Valley Water Company. Upon the completion of this appraisal, the people should be given an opportunity to decide how much of the Company's property should be bought by the City. While it is advisable to guard against duplication, a large part of the Company's plant will not be needed by the City. In view of the present necessities, it might be advisable, in spite of the bad precedent established by such a course, to allow the Company to raise its rates, on condition that the money so obtained should be used making needed extensions to its system.

Mr. O'Shaughnessy called attention to the forty-years struggle for a municipally-owned water-system and to the necessity for immediate action to increase the available water-supply of the City. In the latter part of 1913, the board of supervisors decided to condemn all of the properties of the water company that would be needed by the City. While the necessary preliminary steps were being arranged, representatives of the City and Company met and agreed upon a price of $34,500,000. The condemnation proceedings were dropped pending an election, which resulted in the defeat of the proposal to purchase. Had this proposal carried, the quickest and best way to increase the available water-supply of the City would have been to complete the Calaveras dam and to build a pipe-line from Sunol to the City.

A temporary supply can be obtained from wells within the city limits, and the City is now supplying a few consumers in Visitacion valley in this way. Wells cannot be relied upon for a permanent supply, however, as

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the quality of the water obtained from the upper strata will be seriously affected when the population in the vicinity of the well becomes dense. Some deep wells have had to be abandoned because the water obtained from them was heavily mineralized. The consumption of water in the City increased from 35,600,000 gallons per day in 1910 to 39,670,000 gallons per day in 1913. In 1914 there was a slight decrease, probably due to a careful system of waste-inspection and to an increase in the number of metered services. At present, 20,000 out of a total of 72,000 services are metered. It is probable that, by increasing the number of meters in use, the consumption for a time could be kept nearly stationary, but additional supplies should be developed to tide over the period of at least seven years that must elapse before the Hetch Hetchy supply can be made available.

Considerable preliminary work has already been done in the Hetch Hetchy valley but the difficulty of disposing of the bond issue has delayed construction. These bonds bear 4½% interest, and are not attractive to investors at the present time. The City is now considering an offer by a banking syndicate to finance the construction of the system under the following terms: all unsold bonds are to be purchased at once by the syndicate, the City is to be furnished the amounts needed to prosecute the construction upon demand, and the rest of the money is to remain on deposit until needed, drawing 2% interest.

Mr. Galloway called attention to the large possibilities for power-development in connection with the Hetch Hetchy project. While the City itself could not use all the power available and might not find it advisable to sell power at retail, the surplus could doubtless be sold at satisfactory prices to the power companies. There are large engineering problems in connection with the Hetch Hetchy project, but there is no doubt but that they can be satisfactorily solved. The Spring Valley plant is well-built and in good condition. Besides the distribution system, the reservoirs will be needed to provide against a possible accident to the long conduit from the Sierras such as might result from an earthquake.

The main difficulty with the water situation is that it has thus far been impossible to get the people of San Francisco to agree on any one course and follow it out. As soon as that can be done the other difficulties can be easily surmounted. The best solution of the entire problem would be for all the cities around the bay to unite in the formation of one water district and share the expense of developing the Hetch Hetchy supply. While it is probable that such a district will be formed eventually, it would not be advisable for San Francisco to wait until the other bay cities can be induced to join such a movement, but whatever measures might be taken should have that end in view.

In the meantime, construction should be started on the Hetch Hetchy system and the Railroad Commission should be asked to make a valuation of the Spring Valley system for purposes of condemnation. The people have confidence in the Commission and would probably vote in favor of the purchase of the system at a price established by its authority. The Exposition has given an example of what a commission of citizens can accomplish with the support of the general public. A similar commission should be appointed to have full charge of the water question, holding office until the work is completed.

In the general discussion that followed the main addresses, Mr. Hermann Schussler, for many years chief engineer of the Spring Valley Water Company, advocated the gradual development of the nearby water resources, stating that these would furnish 175,000,000 gallons per day. Under present conditions, the Company cannot be expected to make expenditures for extensions of the present system, but if allowed an increase in rates and given a guarantee that these rates would not be changed for ten years, it stands ready to make the necessary extensions.

In response to inquiries as to the length of time which the Railroad Commission would need for a valuation of the water company's holdings, Mr. O'Shaughnessy stated that about six months would be necessary. He recommended the immediate expenditure of $500,000 for wells and $1,250,000 for mains in the outlying districts.

Since this meeting, a committee of accountants has reported to the City that the bond syndicate plan will result in an actual saving of $1,000,000 as compared with the usual practice of selling the bonds from time to time when money is needed for carrying on the work. This computation is based on assumption that with money always available, as under the syndicate plan, it will take only five years to complete the project, while eight years will otherwise be necessary. While this assumption may be too favorable to the syndicate plan, on the other hand, the committee assumed that the City will be able in the future to sell 4½% bonds at par, which is doubtful. Even if the syndicate plan should cost the City a little more in interest, in view of the uncertainty as to the state of the money market during the next few years, together with the manifest advantage of having the money always available without delay, it would seem prudent, at least, to accept the syndicate's offer. And prudence is advisable in questions involving a city's water-supply.

While there is still more or less disagreement as to details, it may be noted that, in spite of the warmth engendered by the recent campaign, there is substantial agreement by all factions on the main points of future procedure. These are appointment of a commission to have charge of the whole question, immediate construction of the Hetch Hetchy system, and valuation of the Spring Valley system by the Railroad Commission. While this course may not necessarily be the wisest one, it should, if followed out consistently, result in a solution of the water problem that will be satisfactory to all concerned.

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REVIEW OF THE MONTH

ENGINEERS and others who have been annoyed by being obliged to send either money order or coin in small amounts whenever they wanted a topographic sheet or other Government publication, will be glad to know that the Superintendent of Documents is now issuing books containing twenty 5-cent coupons which are good in exchange for Government publications until used.

CENTRALIZATION of control has been extended by an order recently issued by Mr. Franklin K. Lane, Secretary of the Interior, with reference to the administration of the United States Reclamation Service. Since its creation eleven years ago, the service has been controlled in part from Washington, leaving many matters pertaining to the individual project managers for determination and settlement at the district offices. Secretary Lane's order, however, abolishes many of the local offices and establishes general headquarters for all branches of the service at Denver, as a point as nearly central as possible with respect to all of the work under way. While there will doubtless be some objection from the towns where branch offices have been maintained, there is no doubt that the change as a whole is for the good of the service and will therefore meet with public approval.

TESTING of cement for soundness by subjecting a day-old pat to high-pressure steam for an hour or more, has been frequently advocated in the past few years. On the other hand, many objections have come from cement manufacturers who declared that sound cements were being rejected by the use of this test. A recent bulletin of the United States Bureau of Standards, giving results of an investigation by two of the Bureau's engineers, Messrs. R. J. Wig and H. A. Davis, seems to bear out this contention. An exhaustive series of experiments was conducted and the investigators concluded that while the high-pressure test was of value for cement which was to be used in structures subjected to high-pressure steam, it was of little value for cement for ordinary uses. The desire for an accelerated test for cement is natural, but the test of time continues to be the most reliable that can be made.

PROGRESS in the development of the Rittman processes for the production of gasoline and of benzol is reported in a recent statement issued by the Department of the Interior. The gasoline process has been brought to a point where it is now ready for large scale industrial application and it is expected that the same can soon be said of the benzol process. Commercial concerns in all parts of the country are invited to make use of these processes. The only condition is that all discoveries be made available to the general public like the basic processes of Dr. Rittman. Thus we have the spectacle of the Federal Government through the Patent Office, doing all it can to encourage monopoly and through the Bureau of Mines, trying to circumvent monopoly.

STANDARDIZATION of road specifications is receiving attention in states other than California. The people of Montana have recently enacted an amendment to their state highway law, providing that all bridge contracts shall be let in accordance with plans and specifications standardized and prepared by the State Highway Engineering Department; the plans to be placed on file with the county clerk for 30 days prior to letting contracts. Under these conditions, Montana should be able to obtain not only cheaper but better results than were possible by the former method. In California, it has been proposed to consolidate all highway engineering within the state under the jurisdiction of the state. Many of the smaller counties and road districts that do not feel able to pay for the highest type of engineering skill could thus take advantage of the concentrated experience and knowledge of a thoroughly competent engineering staff, which in itself is the best possible guaranty of satisfactory results.

ROAD-CONSTRUCTION by convict-labor was also provided for by the California legislature. This has been and is being tried in a number of states, the principal opposition coming from the labor-unions, who oppose any employment of convicts that results in their competing, in even a remote degree, with free labor. In the particular measure, this objection is met by the provision that convict-labor is to be employed only on the mountain laterals which might otherwise not be constructed at all. It is assumed that by employing convicts in building these roads a considerable saving can be made. In the communities that have given this method a trial, there seems to be more or less dispute as to the actual saving as compared with free-labor construction, but most of those that are doubtful regarding its economy neglect the fact that the convict must be maintained anyway, whether he is employed in useful labor or not. Then, too, the value of the system as a humanitarian and reformatory measure is generally conceded.

EXTENSION of the Kern River oilfield is probable as a result of the Standard Oil Company's operations to the west of the present field. During the boom that followed the first discovery in 1899, 'wild-cat' wells were drilled on all sides of the proved field, but with-

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out obtaining oil in paying quantities. Hope of lower productive strata was given up when a test well in the proved territory was drilled to a depth of nearly five thousand feet without results. About three years ago, however, the Standard Oil Company commenced operations on the so-called Kern River front. Several wells were drilled and some oil obtained, but the results in general were not encouraging. A short time ago a well was brought in at a depth of 3300 feet which is producing 400 barrels per day. The bringing-in of this well gives a speculative value at least to a considerable area of land, which is directly adjacent to the railroad and to the state highway, so that transportation facilities are excellent. If conditions in the oil and in the money market were better, a fair-sized boom would now be in progress.

PRODUCTION and consumption statistics for April, however, give scant encouragement to the operator who wishes to commence drilling new wells. Although wells having an estimated production of 28,000 barrels a day were shut in, the daily surplus for the month was nearly 5000 barrels more. In such a situation the prudent operator is 'sitting tight' and devoting his energies to reducing expenses rather than to increasing them.

COST of physical structures is an important consideration in the valuation of the property of any public-utility corporation, whether for rate-making or condemnation purposes. Whether the actual cost of construction or the reproduction cost at the time the valuation is made should be used in this determination is a debatable question. It is probable that it would not be advisable to use either method invariably, although, in general, the use of the reproduction cost is preferred. But whichever method is used, it should be followed consistently or there is danger of great injustice being done, either to the corporation or to the general public. There seems to be a tendency on the part of those in the employ of public-service commissions to use neither method consistently, but for each individual computation to be based upon whichever method gives the lower value to the property. Thus, in the case of a water company, the cost of trenching is figured on the basis of doing the work all at once with the newest improved machinery. But, when it comes to computing the cost of cutting and replacing pavement for trenches, no allowance is made where the street was unpaved at the time the pipe was laid, but has since been paved. Corporation-regulation is necessary and may be entirely beneficial. Corporation-baiting must in the end react upon the entire community.

TWO of our American universities have achieved an educational scoop by adding Mr. Frederick H. Newell and Mr. Elwood Mead to their respective faculties. Mr. Newell has taken charge of the school of civil engineering at the University of Illinois. His career as chief engineer, and finally director, for the United States Reclamation Service is too well known among the engineering fraternity to require mention here. Every project planned and brought to completion by the Reclamation Service stands as a monument to Mr. Newell's ability as an engineer and organizer of large projects. He is so pre-eminently an engineer of the world that it seems almost to be regretted that his ability and experience are to be confined to one institution of learning. On the other hand, the experiment station at the university has always made it a practice to give general publicity to the results achieved in all of its investigation work. Consequently the world at large will undoubtedly participate in the benefits of Mr. Newell's work in the future as it has in the past. Of equal importance is the acceptance by Mr. Elwood Mead of the professorship of rural institutions at the University of California. It will be remembered that, following many years of successful practice in irrigation and reclamation work in the west of this country, Mr. Mead some seven years ago went to Australia to become chairman for the River and Water Commission of Victoria. Having completed the organization and direction of the work which he had undertaken in the Antipodes, he has returned to California, where his work in this state will undoubtedly have a great influence in the conduct of the many land-improvement projects now under way and yet to be developed. It is significant to record the tendency on the part of our great institutions of learning to obtain the services of men as teachers who have made marked success in the actual practice of their professions. A common impression of a so-called typical college professor is that of a bespectacled biped of attenuated figure, whose discourse consists of polysyllabic words which even he at times does not understand. This type is fast disappearing although it is not always easy to obtain the services of a man who really knows, while it is even more difficult to find one who has also the ability to transfer his knowledge to others. The two universities are to be congratulated upon their good fortune, as are the undergraduates for the opportunity thus placed before them.

CALIFORNIA is doubly fortunate in the search for new timber in having secured the services of Mr. J. B. Davidson of Iowa to occupy the newly created chair of agricultural engineering. Mr. Davidson is to make his headquarters at the university farm at Davis and will direct especial attention to the testing plant for agricultural machinery. In the craze for efficiency, the introduction of scientific management and the tendency to test everything before using, agricultural machinery has thus far been overlooked. As a result the progress in design and selection of materials has not been nearly so marked as in the development of other engineering apparatus. Under the stimulus that adequate testing will undoubtedly give, we may reasonably look for a marked improvement in agricultural implements of all kinds, and possibly a resulting decrease in the cost of living.

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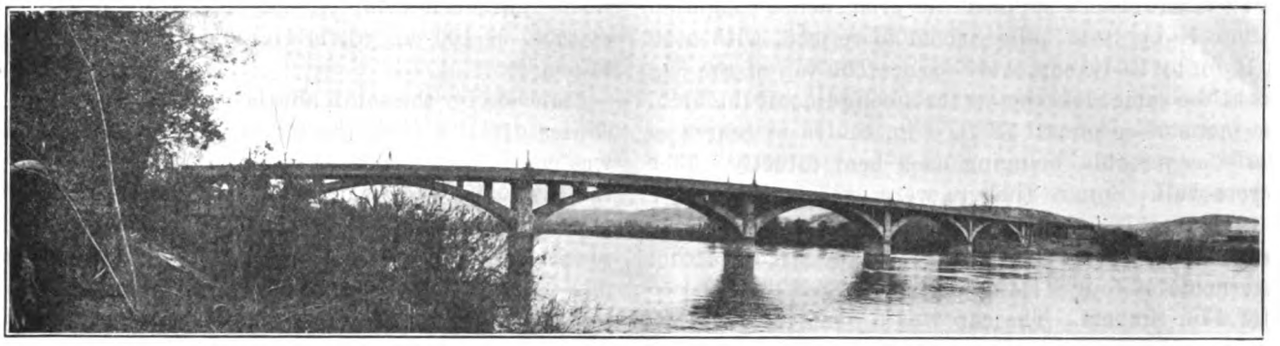

The Reid-Ferry Bridge Over the Sacramento River

By R. T. ENGLISH*

The recently-completed Reid-Ferry bridge on the state highway about one mile west of Redding, is the first concrete bridge to be built over the Sacramento river and is also one of the longest concrete bridges in the state.

The bridge is a five-span concrete-arch structure of open spandrel-wall design. The arches are all of the same shape and size, each having a clear span of 108 ft. or 115 ft. centre to centre of piers. Each arch is composed of two concrete ribs, 3 ft. 6 in. wide and 2 ft. 8 in. thick at the crown. The intrados of the arch has two radii, while the extrados has but one. The rise of the arch is 19 ft. 6 in. from the spring line to the centre of the arch. The bridge-floor is 10 in. thick and 24 ft. wide. It is supported by cross-walls 8 in. thick. The overhang of the floor is relieved by brackets of ornamental design.

Test-borings determined the position of bedrock to range between 11 ft. below low-water at pier No. 1 to 8 ft. below low-water at pier No. 4. At pier No. 1, bedrock was covered by 8 ft. of coarse gravel, while at pier No. 4 it was exposed. The piers were carried 18 in. into bedrock. Hollow piers were specified in the original design, but after constructing pier No. 1 in this manner, the contractors decided that solid piers could be built more quickly and with less expense. Time being an important consideration, piers No. 2, 3, and 4, with the consent of the designing engineer, were built solid.

The original intention was to complete the south abutment to the spring line, and then to time the construction of the arches and the remaining piers so that an arch would be completed at about the same time as the pier ahead of it. Delays in completing the excavation for the south abutment, however, caused the adoption of a different plan. Pile-bents were driven from the south bank of the river to pier No. 1. The pile-driver was then used for driving the cofferdam for the pier. Each piece of sheeting for the cofferdam was made of three 2 by 12-in. by 12-ft. planks, securely spiked together. The centre plank protruded 3 in., giving a tongue and groove effect. The frame of the cofferdam was made of 10 by 10-in. timbers. The first or top frame for the cofferdam was made on the south bank of the river and was floated to place and securely anchored to the pile-bent nearest the cofferdam. Sheet piling as described above was then driven to refusal around the cofferdam. Panels were made of six 2 by 12-in. by 12-ft. planks, and these were placed around the outside of the cofferdam and tied securely to it. A space of four feet was left between the panels and the sheet piling. Dirt and straw were carried from the banks in small barges and packed by ramming into the space between the panels and the sheet piling. Three pumping units, each composed of a six-inch centrifugal pump belt-connected to a 20-hp. motor, were mounted separately on small barges. The barges were towed out to the cofferdam and the pumps used while the excavation was in progress. The excavation was done with pick and shovel and was carried on continuously with 10 men on a shift and three 8-hr. shifts. The cofferdam was 25 ft. long and 12 ft. wide.

The pile-driver remained at the cofferdam while the excavation was being made and drove the sheet-piling as the excavation progressed. The gravel in the river was so compact that it was not possible to drive the piling more than two feet in advance of the excavation. When bedrock was reached and cleaned off, and the sheeting had been driven to the bedrock, the pile-driver was moved ahead to drive the pile-bents as far as the next pier. The leaks in the cofferdam were then caulked as far as possible. Holes 18 in. deep were drilled in the bedrock, and loaded with small charges of dynamite. In this way, the bottom of the hole was leveled approximately. A sump was made at one end outside the concrete line and drains were run toward it from all parts of the excavation, keeping all seepage water from the concrete. The concrete for the footing was poured first, and then that for the pier up to the spring line, the latter operation being completed in one day. Practically the same method of construction was used for all the piers.

*Consulting civil engineer, Chico Construction Co., Chico, California.

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For falsework to support the arch, bents composed of four 10 by 10-in. piles driven to refusal, with a 10 by 10-in. by 24-ft. cap, were used. The top of the cap was at the same elevation as the spring-line of the arch. The bents were placed 12 ft. 3 in. centre to centre as nearly as possible, bringing each bent directly under a cross-wall. Square timbers were used in preference to round, as it was thought that their salvage value would be greater. The bents for the arch-centring were made of four 4 by 6-in. strips of red fir and two 6 by 6-in. timbers. The cap was 6 by 6 in. by 24 ft. long.

The uprights were spaced so that 6 ft. of clear space was left in the middle of the bridge. By this arrangement it was possible to lay light track on the caps of the pile-bents immediately after the completion of each pier and use this track for transporting material. Small push cars were used for reinforcement and lumber, and Koppel side-dump cars, with a capacity of 18 cu. ft., for the concrete. A Ransome-Crummey concrete mixer with a capacity of 12 cu. ft. was used. It was equipped with a charging hopper and was driven by 9-hp. Fairbanks, Morse & Co. gas-engine. The mixer was placed on the south bank at the proper elevation to discharge concrete directly into the Koppel cars. Turnouts were provided at intervals of 125 feet. One hundred cubic yards of concrete could be poured in an eight-hour run.

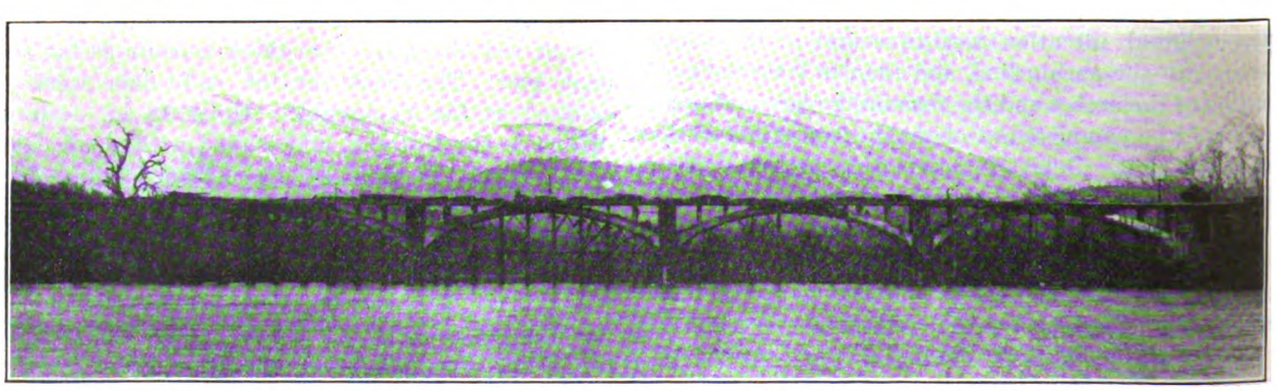
In constructing the spans for the bridge, the forms for the arch-rings, cross-walls, and floor were erected, and then the concrete was poured in spans No. 2, 3, 4, and 5 in one continuous run, commencing with span No. 5 and working back to pier No. 1. For this part of the work, the concrete was hoisted to the floor level by hauling the cars up an incline track using the donkey-engine on the pile-driver for motive power. This track ran from the mixer near the south abutment, to the crown of the arch for span No. 1, where a deadman was placed. A cable with a grab-hook was run from the drum of the donkey-engine through a sheave attached to the deadman, and to another sheave directly above it. Loaded cars were hauled up from the mixer to this point, the hook detached, and the car pushed to its destination while another was being hauled up the incline. After the arch-rings and cross-walls had been completed as far as pier No. 1, an average of 100 cu. yd. in eight hours could be maintained.

Concrete for the south abutment was poured through chutes directly from the mixer. When the abutment was completed, forms for span No. 1 were erected and the arch-ring was poured. The forms for the ornamental brackets and for the rest of the floor were then placed and concrete for these was poured as far back as pier No. 1. The incline track was then removed and a skip-hoist discharging into the concrete-cars was used for the rest of the work.

After the concrete had set sufficiently, work was started on the removal of the falsework. The forms for the floor-centring and the cross-walls were removed first. The salvage-lumber was hoisted to the bridge-floor with hand-lines, the nails pulled, and the lumber cleared and made ready for use in the rail-forms. The centring was then struck, and the lumber placed on the pile-bents. A cable was run from the donkey-engine for the full length of the bridge and through a sheave on the other bank. The centring was then pulled to the bank, cleared, and piled for storage. By taking a single hitch to a pile-bent, it was usually possible to pull a complete bent without difficulty. The bents were pulled to the bank and torn apart after being landed. After the bents had been pulled the back line was attached to the arch-ring forms. A small part of the ring near the spring-line at the far side of the arch would be removed. The entire arch-ring would then fall in the river in one piece and could be pulled ashore with the loss of very little good lumber.

After removing the falsework, the concrete bridge-rails were constructed. At the same time, the back filling was made at both abutments. About 1000 cu. yd. had to be moved at the south abutment, the work being done with a Fresno scraper, using a load and a back line from the drum of the donkey-engine. With this arrangement, two men could move 75 cu. yd. in a day. After this, the approaches were filled and a two-inch asphalt floor laid.

The bridge is 639 ft. long and the roadway is 21 ft. wide in the clear. The top of rail is 36 ft. above low water. The piers and abutments are all carried to bedrock, the south abutment being 61 ft. 6 in. from



VIEW OF BRIDGE DURING CONSTRUCTION, SHOWING FALSEWORK IN PLACE.

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top of rail to bottom of footing. The completed structure contains 2700 cu. yd. of concrete and 110 tons of steel reinforcement. Two hundred thousand feet B.M. of lumber was used during the construction, 100,000 ft. of which was recovered. Standard portland cement was used throughout for the concrete on all parts of the work.

Work was started July 1, 1914, and completed March 1, 1915. The contractor's price was $49,640. A. V. Saph, Berkeley, California, was the designing engineer. The Chico Construction Co. of Chico was the contractor. J. H. Polk was general superintendent for the company and R. T. English, superintendent of construction.

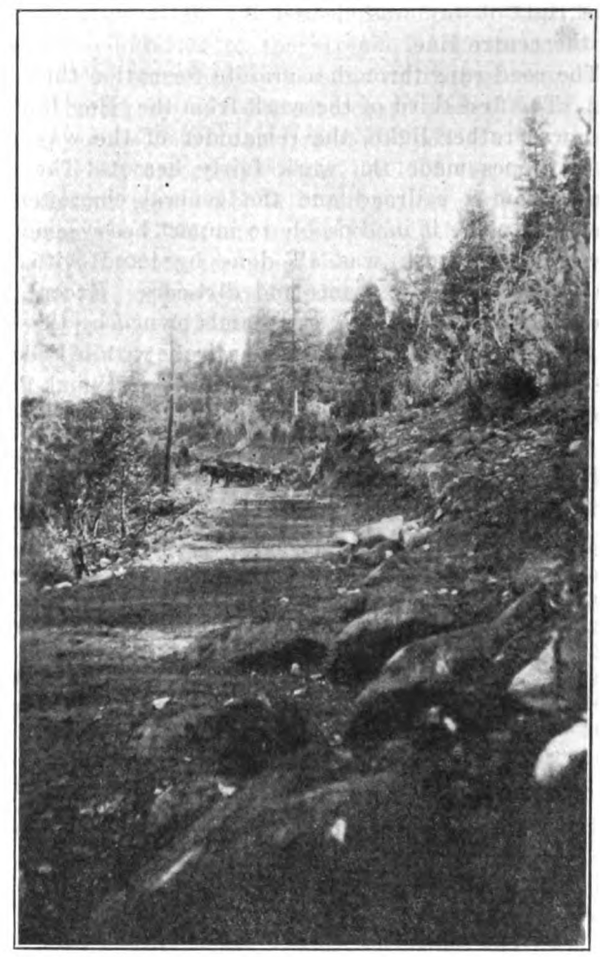
Construction of Road Into Hetch Hetchy Valley*

The Hetch Hetchy valley, the site of the proposed reservoir for the future water-supply of San Francisco, lies in the Sierra Nevada mountains about fifty miles from railroad transportation. The nearest wagon-road terminates at the 'Hog Ranch,' from which a rough pack-trail leads to the proposed dam-site, about nine miles. On account of the great amount of material that must be hauled during the erection of the dam and other structures, it has been decided to build a railroad from some point near Cooperstown on the Sierra railway to the floor of the valley. The exact location of the part of the line nearest the present railroad has not yet been decided. To facilitate the

PART OF ROAD DURING CONSTRUCTION.

preliminary work in connection with the entire water-supply project, it was decided to construct the road-bed on the part from the 'Hog Ranch' to the dam-site before commencing work on the remainder of the road, thus providing a continuous wagon-road to the floor of the valley.

A contract for this part of the work was let July 8, 1914, and the work was completed early in March, 1915. The road is 9.09 miles long. Starting from the 'Hog Ranch' at an elevation of about 4510 ft., the road ascends on a maximum grade of 4% until a summit elevation of about 5065 ft. is reached at a point about three miles out. The road then descends with a 4% maximum grade to the damsite at an elevation of about 3870 ft. To continue with a nearly level road from the starting point would have brought the grade into the cañon of the Tuolumne river, where the steep slopes would have made the cost of excavation prohibitive. The maximum curvature is 30° and the total



NEARLY COMPLETED PORTION OF GRADE.

curvature 4734°. From the 'Hog Ranch' to the summit, where the grade will be against loaded trains, the maximum grade is compensated for curvature on a basis of 0.04 ft. per degree, except where local conditions made changes in the rate of compensation advisable. The grade from the summit to the dam-site

*From data furnished by M. M. O'Shaughnessy, city engineer of San Francisco.

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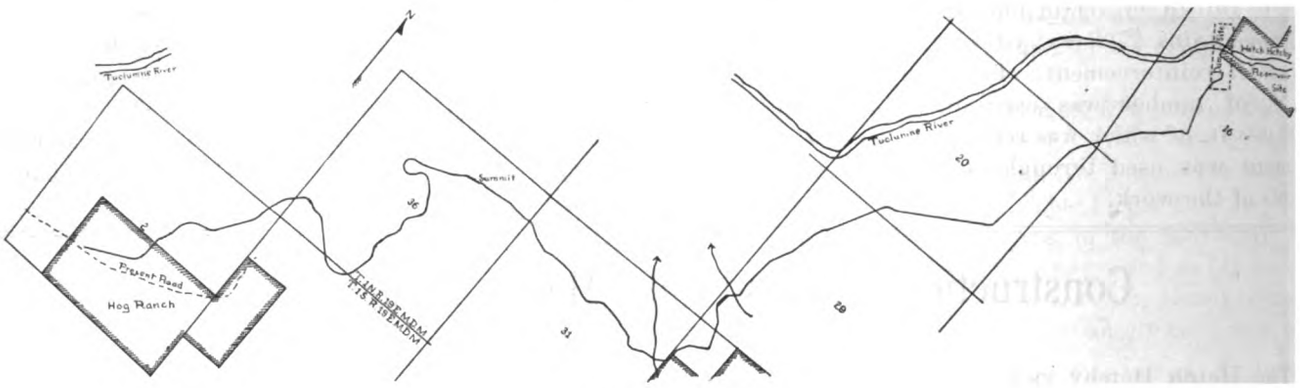

MAP OF ROAD.

will be against empty trains, and compensating the grade on curves was therefore considered unnecessary. The width of the roadbed is 22 ft. throughout, with slopes of 1½ to 1 on the fills. The slopes in the cuts were chosen to suit the individual conditions. On the rest of the railroad a 16-ft. roadbed will be used. The right-of-way was cleared for 30 ft. on each side of the centre line.

The road runs through a granite formation throughout. The first third of the work from the 'Hog Ranch' end was rather light; the remainder of the way, the steep slopes made the work fairly heavy. The distance from a railroad and the general character of the work made it inadvisable to import heavy machinery and the work was all done by hand with the assistance of a few teams and dirt-cars. Except for the small portions which cross lands owned by the city of San Francisco, the road lies entirely within Federal reserves, being partly in the Yosemite National Park and the remainder of the distance, about seven miles, in the Stanislaus National Forest.

Following is a summary of quantities and unit prices paid to the contractor:

13,974.7	cu. yd.	of earth at	$0.40	$	5,589.88
5,042.8	" "	" loose rock at	$0.68		3,429.10
20,835.9	" "	" boulders at	$1.30		27,086.67
97,224.0	" "	" solid rock at	$1.30		126,391.20
14,964.1	" "	" cemented material at	$0.68		10,175.59
56,951.0	" "	overhaul at	$0.01		569.51
292	lin. ft.	12-in. diam. corrugated culvert at	$1.25		365.00
1132	" "	24 " " " " "	2.31		2,614.92
52	" "	30 " " " " "	3.34		173.68
216	" "	36 " " " " "	4.00		864.00

In addition, a number of stone culverts, dry walls, etc., were constructed by the contractor on force account on a basis of actual cost plus 10%. The total payment to the contractor for these items was $4878.56, nearly all of which was chargeable to the construction of this road, making the total cost of the actual construction of the road approximately $182,000, or $20,000 per mile. The total yardage was 152,040, or about 16,700 cu. yd. to the mile.

The Utah Construction Co., of Ogden and San Francisco, was the contractor on the work, which was done under the general direction of M. M. O'Shaughnessy, city engineer of San Francisco.

COST OF ROAD BUILDING WITH TRACTOR

N. Y. Taylor, engineer for Meeker county, Minnesota, has compiled figures showing the cost of building roads in that county with the tractor rig consisting of engine and two graders. He states that this computation includes every item of expense connected with the work, except surveying.

Number of working days	102
Number of miles of road built	36
Wages of operators—foreman, engineer, and two grader men	$1,331.14
4401 gal. Crown gasoline	580.93
403 gal. lubricating oils	129.78
Repairs to graders, sharpening, etc	52.00
Repairs on tractor	43.68
Accident insurance premium	50.00
Depreciation on outfit, 25% on cost of $3,713	928.25
Cost of shed for winter cover	150.00
Total cost for 36 miles	$3,265.78
Cost per mile	90.71

The road was a standard 20-ft. roadway and 36 ft. from edge to edge of the side ditches.—*Better Roads and Streets.*

Granite blocks on a mortar bed is a new development of the Bureau of Highways, Borough of Manhattan, New York City. In place of the usual 1-in. sand cushion an experimental section of the new Third Avenue pavement in the vicinity of 20th street has been laid with a 1-in mortar cushion composed of 1 part cement to 3 parts sand, thoroughly mixed dry and slightly moistened, after the manner of the mortar bed now used exclusively in Manhattan Borough for wood-block pavements. A shallow dry mortar bed was used under several thousand square yards of re-dressed granite blocks in Schenectady, New York, in 1913. After the blocks were laid and rammed, the pavement was flushed to moisten the mortar bed. This is said to be a very satisfactory job. The Third avenue pavement, New York City, is a part of a pavement laid under the usual specifications for first-class grouted granite block, and the results on the mortar-bed section will be watched with interest.—*Engineering News.*

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Colorado River Irrigation and Reclamation Problems*

By J. B. LIPPINCOTT†

The Colorado river rises in the high mountainous regions of Colorado, Wyoming, and Utah, and flows in a general southwesterly direction, receiving the greater part of its waters from its upper tributaries at the union of the Green and Grand rivers at Grand Junction, Colorado. Below this point it enters the Grand Canyon of the Colorado, having eroded its channel through the highest part of the plateau region of southern Utah and northern Arizona, proceeding westerly through the Grand Canyon, crossing almost the entire width of northern Arizona. It remains almost continuously in deep cañons until it emerges therefrom into a narrow valley near old Camp Mojave, a short distance above the town of Needles, California, where the river is crossed by the Santa Fe Railroad system. Below this point the river again enters the cañon for a short distance and does not pass through much valley land until it reaches the northern limits of the Colorado River Indian reservation near the Parker agency. From this point to the Mexican line, a distance by river of fully 200 miles, the river has eroded a series of narrow ribbon-like valleys ranging from 5 to 10 miles in width.

These valleys are subject to annual overflow during the early summer rise of the river. Their soil formed by the deposit of silt from the stream is fertile. Below Yuma, on the California side and at the international boundary, this valley condition of the Colorado ceases and the broad delta of the stream begins. The true delta of the Colorado extends from the head of the Gulf of California to the international line, and contains about 1,000,000 acres. This lower land is largely subject to annual overflow, and the silt from the stream has produced a fertile soil. The amount of solid matter deposited by the river is estimated to be sufficient to cover 53 square miles one foot deep each year. The great amount of silt that has been brought down by the river and spread over this delta has apparently cut off the northern end of the Gulf of California in the process of its deposition.

The large area now known as the Imperial valley, and previously called the Salton sink, situated just north of the international boundary line and containing over 1,000,000 acres of land, is mostly below sea-level, the greatest depression being about 285 feet. In the lower part of this old marine bed the soil is a dense clay, not covered with river silt, and heavily charged with salts resulting from evaporation. Around the margins of this old sea-bed, where the silt of the river has been deposited in later years, the soil is of good quality.

*Address delivered at the Congress of the Inland Waterways Association of California, San Francisco, March 23-25, 1915.

†Consulting Engineer, Central Bdg., Los Angeles.

The flow of the tributaries which enter the river below the Grand Canyon is variable. The Virgin, Williams, and Gila rivers all drain large areas of desert country, but contribute little water to the Colorado, except during times of unusual rainfall in their drainage basins, when spasmodic floods occur. The total drainage area of the river above Yuma, including the Gila basin, is 225,000 square miles. This area is entirely within the territory of the United States. The only rivers on this continent having a larger drainage area are the Missouri and the Columbia.

The Colorado river is the longest stream on the Pacific coast south of Alaska. It is officially a navigable stream. Commercially its navigation is a failure owing to the shifting and shallow nature of its channel. In this respect it somewhat resembles the Missouri. Below the international boundary line there are no tributaries to the stream. Like many other silt-bearing streams, it has built up its bed and immediate banks by silt deposits, until for a large part of its course below the Grand Canyon the channel is in a slightly elevated trough. In 1905 the river broke through its western bank at the intake of the Imperial canal and, while it has been successfully diverted from discharging into the Imperial valley, it has not been turned into the original channel through which it formerly discharged into the Gulf of California. It is now flowing near the top of the low divide which separates the Imperial valley from the slopes leading into the Gulf of California. The greater portion of its waters are being discharged through Volcan lake and the Hardy-Colorado, which is situated on the western side of the delta. Volcan lake, which is situated on this low summit, is rapidly filling with mud, and continuous effort is necessary to keep the river deflected toward the south. The United States government has built a levee along a large part of the northwesterly bank of this stream to protect Imperial valley from overflow. Breaks have occurred in this levee from time to time, and at present further work is being done jointly by the Federal government and the irrigation interests in Imperial valley to maintain this levee. It is the opinion of many engineers that the river must ultimately be turned into the old channel.

Before the great break in the west bank in 1905 some of the spring flood-water that overflowed the banks of the river south of the international boundary drained in a southwesterly direction into what is known as the Hardy-Colorado, which follows a low depression on the western side of the delta. The Hardy-Colorado formerly entered the main stream at a point about 15 miles above the head of the gulf. At the junction both rivers were tidal in their nature, and the Hardy at its mouth had the appearance of

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being fully as large a river as the main Colorado. For a short distance it was as navigable as the Colorado itself.

The treaty of Guadalupe Hidalgo, which was signed at the conclusion of the Mexican War in 1848, had attached to it an official map, carrying the signatures of the treaty commissioners and showing the boundary lines proposed by the treaty between the two countries. This chart shows the boundary line between California and Lower California as starting at the northern point of Montague island, which is situated in the Gulf of California, and running thence to a point one marine league south of San Diego bay. The treaty, however, provides that in order to facilitate the demarkation on the ground of this international boundary line, that the starting point should be considered as the junction of the Gila and the Colorado. As the Gila enters the Colorado over 100 miles above the Gulf of California, it is suggested that the American Commissioners may have been misinformed as to its location and had confused it with the Hardy-Colorado, which joins the river near its mouth. This is suggested by the fact that the navigation of the 'Gila' is elaborately protected in the treaty stipulation, whereas the Gila at Yuma is a dry wash for most of the year. This navigation feature was more important at the time of the treaty in 1848 than at present. This change made in order to facilitate the survey, apparently cost the United States the great delta of the Colorado river.

The position adopted for the international boundary line is particularly unfortunate because immediately to the west of the Colorado for a distance of over 20 miles there is a series of low mountains and sand-dunes which project across the boundary line for a distance of a few miles in such a manner as to prevent canals from the Colorado river for the Imperial valley being kept within the territory of the United States. This physical condition has led to much international complication concerning the waters of the river. The Mexican authorities as well as existing private and court agreements provide that where water diverted from the Colorado for the benefit of Imperial valley passes through Mexico one-half of the same must be delivered on demand to lands in Mexico at the minimum price for which water is sold from the system in the United States. Another unfortunate feature of the present situation is that the levees for the protection of the Imperial Valley district must be built and maintained in Mexico.

The lower portion of the Colorado is subject to a vigorous tidal flow. The stream rises during the months of May and June, the flood period culminating about the middle of June. This summer rise is caused by the melting of the snow on the high mountains of Colorado and Wyoming. Following this comes a gradual recession of water until September. The river is subject to sudden and short rises in the late summer, caused by the thunder-storms which prevail in the high plateau region of Arizona and southern Utah. The river usually reaches its lowest stages in midwinter when the mountainous part of its drainage area is frozen and there is little rain in the southern part.

The climatic conditions along the lower Colorado are semi-tropical. The heat is dry and intense, but not more exhausting than that of the Atlantic coast as far north as Virginia. Sunstrokes are almost unknown. The winters are mild and pleasant. The silt carried by the stream is of such high fertilizing quality that farm land irrigated by the water from the river improves in quality. The period of highest water is the period of greatest demand for irrigation.

We therefore have in this southwestern desert region a condition resembling the Nile. A series of long narrow valleys like those found in Upper Egypt, a great delta plain at the mouth of the stream, an annual rise in the early summer with inundations of marginal lands, a semi-tropical climate, and a great river rising in interior mountainous regions and flowing to a landlocked sea, all resemble conditions in Egypt to a striking degree, with the one disappointing exception of an international boundary line crossing the stream at the head of its delta.

We have along this lower river, and within the territory of the United States, an opportunity for great development; a region where agriculture, mining, and commerce will certainly increase upon the construction of beneficial public works. It is probable that over 1,000,000 acres in the United States below the Grand Canyon will be ultimately developed and occupied. There is additional irrigated and irrigable land above the Grand Canyon. There are, in addition, 600,000 acres of irrigable land in Mexico. As the rainfall varies from three to five inches per year in the region below the Grand Canyon, and the growing season is practically continuous throughout the year, temperatures being high and the annual evaporation as great as 90 inches, irrigation is absolutely essential to the development of this latent empire. With irrigation these very conditions produce phenomenal growth of vegetation. Without it the entire area must remain a hopeless and perpetual desert.

Some of the lands along this stream are still a portion of the public domain. The waters are assembled from seven states. We are now at the threshold of a virgin region, and upon our action is dependent the character and success of the development that will follow. Surely this great natural public opportunity should be so handled as to inure to the greatest benefit of the greatest number, and the manipulation or attempted monopoly of the waters of the river by a few individuals or corporations should either be prevented or made subject to careful regulation.

Arthur P. Davis, director and chief engineer of the United States Reclamation Service, in an article on the Colorado river, written in 1902, shows that irrigated areas in southern California support an inhabi-

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tant to each eight-tenths of an acre. He writes as follows: "On the above basis the irrigation of 1,200,000 acres from the lower Colorado would give opportunity for a population of 1,500,000 people, or a community more numerous than the entire population of any one of twenty-three states of the Union."

The discharge of the Colorado river at Yuma, in its present unregulated condition, ranges from about 4000 cu. ft. per second to 150,000 cu. ft. per second. During 1903, which was an average dry year, without regulation the river could have sufficiently irrigated but 400,000 acres, based on the assumption of a depth of water annually applied of 5½ ft., which was the amount being used in Yuma at that time. This allows for seepage losses in transit through the canals. If 1,000,000 acres of land were irrigated that year, in addition to the normal flow of the stream in its low-water period, 1,750,000 acre-feet would have had to be drawn from storage reservoirs. If 1,400,000 acres were to be irrigated, the necessary amount of water required from storage reservoirs in 1903 would have been 3,500,000 acre-feet. This would indicate that if adequate storage were provided, practically all the irrigable lands along the lower Colorado river in the United States and in Mexico could be supplied with water. This is exclusive of large areas in the drainage basin of the Gila river and the high mesa lands which border the stream, where pumping would be necessary. In the basin of the Gila river, 220,000 acres are now being supplied with water from the Roosevelt reservoir, and probably enough more could be adequately served by the regulation of the Gila river at San Carlos, the Verde river at the Horseshoe reservoir, and other sites to bring this area up to 400,000 acres. On the upper Colorado above the Grand Canyon, in the states of New Mexico, Colorado, and Utah, other areas could be extensively reclaimed. The Turley reservoir on the San Juan river has a capacity of 1,500,000 acre-feet, with a large water-supply, and over 1,000,000 acres of fertile land can be irrigated from it, while other areas along the Green and the Grande rivers in Colorado and Utah could be supplied from the Kremmling and Brown's Park reservoir sites.

The violent floods that occur on the lower Colorado do great damage to the low valleys below the Grand Canyon and are most erratic in their course across the lower delta, frequently endangering the low-lying Imperial valley. The banks of the river consist mainly of loose silty soil subject to severe erosion by the floods. To protect these valley lands simply by the building of earthern levees is difficult because they are easily cut away by these violent floods unless the levees are elaborately protected by riprap or mattresses such as are used on parts of the lower Mississippi.

The building of storage reservoirs on the Colorado river and its tributaries will not obviate flood dangers on that stream. A search of the records of the United States Geological Survey and of the Reclamation Service shows that storage capacity, within reasonable limits, exists for the impounding of 8,500,000 acre-feet of water. Bedrock conditions have not been determined at all the dam-sites.

The long ribbon-like valleys of the Colorado between Yuba and the Grand Canyon suggest the possibilities of storage on lower portions of the river. This, however, is not practical because of the volumes of silt carried by the river. Bedrock has not been found at any feasible dam-site, although extensive explorations have been made for it. Above the Grand Canyon, however, there are reservoir sites where the water is clear, such as at Kremmling on the Grand river. At such points storage would be most effective.

The gaugings of the river at Yuma from 1902 to 1912 inclusive show a minimum discharge in 1902 of 7,960,000 acre-feet and a maximum discharge in 1909 of 26,000,000 acre-feet. If 1,400,000 acres were to be covered 5½ feet in depth in a year, this would call for 7,700,000 acre-feet, which the river could have supplied in 1902 if sufficiently regulated. In 1909 the 8,500,000 acre-feet of storage would have been but 33% of the total annual discharge, assuming that all of the reservoirs had been built and filled. The building of these storage reservoirs would not have obviated the necessity of the construction of levees, but it would have afforded some relief. The month of greatest flood in 1909 was June, when the river reached a maximum flow at Yuma of 149,500 cu. ft. per second, yet in that entire month the total discharge was but 6,250,000 acre-feet, or less than the aggregate capacities of the storage sites on the river. This would indicate that the peak could have been taken off the most violent floods, but probably in such a wet year the reservoirs would have been well filled in prior months.

It would demand months of study to determine accurately the volumes of available water-supply at proposed reservoir sites and diversion points, bedrock and other structural conditions at the dam-sites, the areas of irrigable lands, and the effect of state laws and international agreements. There should be a compilation of the work that has already been done by the different departments of the Government and a co-operation in future work, including construction of storage reservoirs, river control, and forestry. The Colorado river and the lands tributary to it are naturally the 'back country' for southern California. The chief engineer of the Reclamation Service has suggested that they are capable of supporting a population of 1,500,000 with proper control of the stream. Without this control even those areas now under irrigation are unsafe. The cities of California should be interested in the proper development of this region, not only because of the commercial benefits which would result therefrom, but as a base of supplies for the actual necessities of life. We have here an American Nile awaiting development, and it must be treated in as intelligent and vigorous a manner as the British government has treated its great Egyptian prototype.

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Methods and Costs of Construction of Concrete Highways in Orange County, California*

In November 1912 the voters of Orange county, California, approved a bond issue for $1,270,000 for the construction of a system of county highways. This system included in all 107 miles of road, 95 miles of which was to be paved with a four-inch concrete base and an asphaltic-oil wearing surface, and 12 miles of

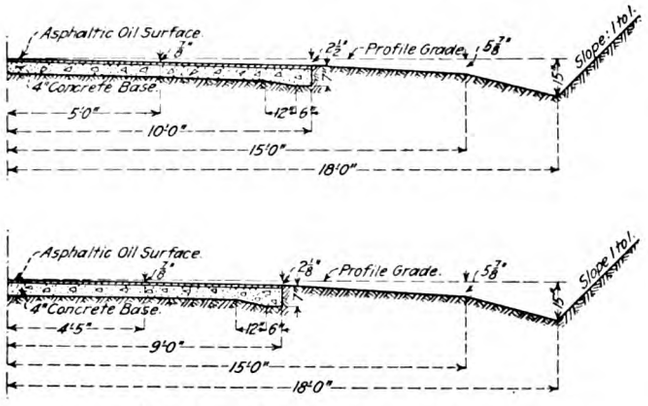

FIG. 1. STANDARD TYPES OF ROAD-BED.

mountain road, which was to be graded only. Active work was commenced in March 1913, and was carried on with such energy that on March 31, 1915, contracts

Road.	Pavement.	Length.	Total Cost.	Cost Per Mile.	Cost. Per Sqr. Ft.
Huntington Bch. Sec. 1.	20' Wide.	5.13 Miles.	$ 58,898.23	$ 11,481.13	$ 0.0987
" " " 2.	18' "	4.34 "	42,282.29	9,742.46	0.0987
Tustin - Orange.	18'-20' "	3.76 "	27,940.31	7,430.90	0.0764
Riverside Road Sec. 1.	20' "	0.34 "	3,472.10	10,211.70	0.1001
" " " 2.	20' "	2.61 "	22,411.34	8,720.30	0.0814
" " " 3.	Graded Only				
" " " 4.	" "	3.73 "	27,108.19	7,267.61	0.0688
" " " 5.	" "	2.45 "	36,936.19	15,075.90	0.1427
Orangethorpe Av. Sec. 1.	18' Wide.	3.24 "	27,773.91	8,572.20	0.0901
Olinda, Anah. Olive Sec. 1	18'-20' "	9.33 "	87,677.38	9,397.36	0.09697
Garden Grove. Anah-Stan-Cypr. Sec. 1.	18' "	7.20	61,708.76	8,582.58	0.09
Newport Ave.	18' "	4.15 "			
" Beach Sec. 1.	18'-20' "	4.43 "	49,286.90	11,125.71	0.1126
" " " 2.	18' "	4.35 "	41,432.81	9,524.80	0.1001
Buena Park Sec. 2. Commonwealth Ave Orangethorpe Av. Sec. 2	18' "	3.52	37,245.71	10,638.00	0.11
Los Alamitos	18' "	4.16 "	68,945.94	9765.71	0.1044
Bay City Sec. 2.	18' "	2.90 "			
" " " 1.	18' "	6.02 "	57,030.69	9,473.53	0.0993
Talbert " 1.					
" " 2.	18' "	2.75 "			
" " 3.	18' "	4.88 "			
Buena Park " 1					
Anah-Stan-Cypr. Sec. 2.					
Laguna Road.	16' "	10.43 "			
Brea Canon	18' "	4.08 "			

FIG. 2. COST OF CONCRETE PAVEMENT ON SEVERAL ROADS.

for the entire system had been let, 101 miles of road had been graded and 91 miles completed. Further than that, when the bids for the last parts of the system had been received, it was found that there would be a surplus of $240,000 remaining after work had been finished. This amount is to be used for building 30 more miles of road. With the fifty-odd miles of state highway and the completion of the county system, there is little of the valley portion of the county that is more than two miles from a hard-surfaced road, while the mountain districts are as well served as could be reasonably expected.

Some features of the methods of construction are of interest. After the grading has been done, the road-bed is cultivated to a depth of not less than six inches and thoroughly watered and tamped. After the tamping is done, a roller weighing not less than 300 lb. to the inch width of rolls is used to render the subgrade still more compact. For the concrete, a 1:2½:5 mixture is used. After being laid, the concrete is protected from the direct rays of the sun and kept wet for 12 days. Both crushed rock and creek gravel have been used for aggregate with equally good results. The standard types of road-bed are shown in Fig. 1. The shoulders are made after the concrete has been laid and are rolled with the same weight of roller as that used for the subgrade.

Road.	Oil Bbls	Cost	No 3 Scregs. Tons	No 4 Scregs. Tons	Cost	Freight	Labor	Total	Cost Per Mile	Cost Per Sq Ft
Huntington Bch Sec 1	606.04	1818.12	1159.60	456.00	443.33	606.42	1615.57	4483.44	874.00	0.77
" " " 2	493.50	1480.53	785.40	380.00	424.74	519.21	1165.40	3589.88	827.10	0.74
Tustin-Orange	467.00	1401.00	979.00	66.00	391.74	549.30	1567.50	3909.54	1037.00	1.11
Riverside Sec. 1.	33.05	117.15	90.00	85.02	81.37	70.20	179.02	443.74	1305.00	1.11
" " 2	310.55	801.43	839.29	92.50	413.68	407.40	627.50	2256.01	864.30	1.00
Orangethorpe Sec. 1.	304.00	1045.76	616.96	316.00	362.94	262.60	619.57	2290.87	704.90	0.86
Newport Bch Sec 2	436.73	1310.19	1348.01	531.61	1065.71	1000.71	1879.62	5256.23	1209.30	1.60
G.G. & A.S.C. Sec. 1.	698.40	2095.20	2472.71	165.00	960.00	1190.58	1539.63	5785.39	974.00	1.00
Comm'with Av & B.P.Sec 2	484.10	1161.84	909.82	939.05	723.54	622.16	919.81	3427.35	974.00	1.07
Newport Beach Sec 1	593.07	1423.37	1106.00	1560.00	943.31	965.36	1374.06	4706.10	1062.32	1.07
Olinda-Ana Olive Sec 1	1248.76	3240.78	2761.83	1562.17	1614.06	1887.22	3417.55	10159.86	1088.92	1.123
Los Alamitos And Bay City Sec 2.	1041.69	2500.06	1620.88	1754.47	1173.66	1213.85	2805.09	7693.58	1089.77	1.17
Bay City Sec 1.	821.57	1971.77	1207.00	1875.56	1179.78	1499.25	2583.91	7234.71	1201.78	1.26

FIG. 3. COST OF OIL-SURFACING.

After the concrete is thoroughly set, it is carefully cleaned preparatory to the application of the oil surfacing. It has been found best to do this part of the work by force account, and much better results are now being obtained than when the surfacing was done by the contractors. First a layer of 90% asphalt is applied in the proportion of $\frac{3}{10}$ of a gallon to the square yard. Then follows a layer of ¼-in. crushed rock, then another application of oil, $\frac{2}{10}$ of a gallon to the square yard, and finally another layer of ¼-in. crushed rock and stone dust.

All bridges and culverts are built of reinforced concrete and are designed to carry a load in excess of present-day requirements. The cost of the concrete foundation and of the surfacing on several of the roads that have been already constructed is shown in Fig. 2 and 3.

The work is being done under the general direction of S. H. Finley, chief engineer for the county highway commission, whose members are D. C. Pixley, R. J. McFadden, and W. T. Newland.

*From data furnished by George R. Wells, Office Engineer, Orange County Highway Commission, Santa Ana, California.

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Gasoline and Synthetic Crude Oil*

By WALTER O. SNELLING†

In the course of some experiments more than five years ago, made for a different purpose than the investigation of the oil used, I placed a small quantity of a transparent yellow lubricating-oil in a bomb-like vessel and heated it to a relatively high temperature. At the end of the experiment I removed the oil from the vessel and was amazed to find that instead of bearing any resemblance to the oil which I had put in, it had the appearance of ordinary crude-oil. The green color by reflected light and the rich red-brown by transmitted light were so unmistakable as to at once lead to further investigation. I subjected the material to fractional distillation, and the surprise which I experienced at the appearance of the oil, changed to amazement when I found that it yielded, on distillation, 15% of gasoline and 30% of kerosene, and that its constitution resembled crude-oil quite as much as did its appearance. Further, the gasoline and kerosene distillates which it yielded were of a clear water-white color, entirely without treatment with acid or alkali, and were free from the odor familiar in 'cracked' petroleum distillates.

The result of this experiment was too remarkable to be credited without further confirmation, and I filled the vessel with some of the same oil I had used before, heated it again to about the same temperature that I had previously used, and for the same period of time. Upon opening the vessel and removing the contents I found, not the material resembling crude-oil that I had obtained before, but apparently only the same oil that I had put in, somewhat darkened in color, but nevertheless different in appearance from the material obtained in the previous experiment.

Evidently some condition existed in the first experiment that had not been present in the second test. I began a series of tests in which I sought by the change of one variable after another to arrive at the identical conditions which must have existed in the first experiment. Only the fact that the bottle of heavy oil used in the first test was still in its place, and the further fact that I had no crude-oil among the materials at hand when I began the experiment kept me from believing that I had made some mistake, and that crude-oil had in some manner found access to my apparatus. After many fruitless experiments I learned what should have been obvious to me from the first, but which, in the surprise due to the unexpected result obtained, had quite passed out of my mind. In my first test, the vessel which I used was about one-fourth full of oil, but in all of the other experiments I had filled the vessel three-fourths full or more, in the effort to obtain as great a yield as possible. I repeated the first experiment, using the vessel but one-fourth full, and heating to about the same temperature, and for the same time as I had done in the other experiments. The result was once more a greenish liquid, and its fractionation again gave 15% of gasoline and 30% of kerosene.

Apparently some change takes place in the hydrocarbon molecules, when a hydrocarbon body is heated in a still one-fourth full of oil, that does not occur when the same hydrocarbon is heated under similar conditions, except that a greater proportion of the volume of the still is filled with oil. With grave doubts and fears, I placed in my retort some kerosene. If this water-white material, after treatment, should come out green in color by reflected light, and red by transmitted light, then indeed I would be convinced that I was dealing with a true transformation into crude-oil. I obtained a liquid which resembled Pennsylvania crude-oil so perfectly that when I placed a bottle of the new product by the side of a bottle of the real crude, it was hardly possible to say which was which, by appearance alone. I next melted some paraffin and placed it in the vessel, and after heating under the prescribed conditions, I obtained a thin fluid, suggesting crude-oil in every way, which on distillation gave somewhat over 15% of a water-white gasoline, free from 'cracked' odor, and other distillates in about the same relationship as in ordinary crude-oil. One after another I tried putting all natural hydrocarbons available through this process. They all yielded materials similar in appearance, odor, and composition. From each I obtained a synthetic crude-oil containing about 15% of gasoline, and other distillates in about the same order as are found in typical crude-oils.

It has long been known that under the influence of high temperatures hydrocarbon bodies could be thermolized, or 'cracked,' and that by this method low-boiling bodies could be produced from hydrocarbons of higher gravity. Indeed, the commercial use of 'cracking' distillation in petroleum refining goes back more than half a century, the first observation of such 'cracking' distillation being said to have been made accidentally, in a refinery at Newark, New Jersey, during the winter of 1861-2. For 30 years after the discovery of methods suitable to 'cracking' distillation, this method was in common use in many of the principal oil-refineries of the world. It was found that by running the stills at a high temperature increased yields of kerosene could be obtained, and the method was found to be profitable, particularly since in the early days of the oil-refining industry, kerosene was the principal product desired. The process was investigated by many able men, and the conditions under which long

*From paper to be presented at the meeting of the American Institute of Mining Engineers, at San Francisco, California, September 1915.

†Pittsburgh, Pennsylvania.

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paraffin chains became broken into two or more shorter chains, under the influence of high temperatures, were determined, particularly as concerns commercial refining operations.

Accordingly it was natural that, with the increased demand for gasoline during the past 10 or 15 years, many investigators should attempt by similar 'cracking' methods to obtain increased yields of low-boiling products. When the vapor of kerosene or any heavier oil is passed through a red-hot tube, thermolization takes place, with the production of considerable amounts of low-boiling products vaporizing within the ordinary boiling-point range of common gasoline. In this and in other similar ways attempts have been made, both on a laboratory scale and in large-size commercial installations, to prepare products capable of replacing gasoline. Of the dozens, or even hundreds, of such efforts, few have had even the slightest promise of success, due to the fact that the low-boiling hydrocarbons produced in the manner described are off-color, and possess an odor so pronounced and disagreeable as to limit, if not prevent, their sale. So acute has been the demand for gasoline at times in the past 10 years that it is possible that the color and odor might have been overlooked if the process had given the large yields that were originally anticipated; but in this respect also, the ordinary 'cracking' methods have met with difficulties, and in general these processes produce considerable amounts of tar and coke, that materially cut down their efficiency.

When the limitations of simple 'cracking' of hydrocarbon oils at ordinary pressures were first understood, efforts were made to bring about destructive distillation under increased pressure. Results showing great improvement over those obtained by the simple 'cracking' methods were given by these processes, which seem to have been first made use of by J. Young, and later developed by Dewar and Redwood, and others. Quite recently, improved processes of 'cracking' distillation under increased pressures have been used commercially by Burton, and are said to have been so developed as to yield products readily salable as substitutes for gasoline.

Efforts have not been wanting to improve the color and odor of the light 'cracked' distillates produced by ordinary 'cracking' distillation. Treatment with sulphuric acid and alkali, in the manner commonly used in the refining of kerosene, have the effect of improving both color and odor to a remarkable extent, and by the use of sufficient acid, colorless products without bad odor can be obtained, but only by the use of such large amounts of acid as to make the process commercially prohibitive, unless the price of gasoline is high. By 'cracking' under increased pressure the amount of acid required for this purification is very greatly reduced, and it is probably due to this fact that the motor gasoline now being developed by Burton owes its commercial possibilities.

It will thus be seen that I cannot claim to be in any way a pioneer in the production of lighter hydrocarbons from materials of heavier gravity. Hydrocarbons have been cracked and broken up into lighter hydrocarbons of lower boiling point, both experimentally and commercially, for a period of over 50 years, and such 'cracking' experiments have been conducted both at normal pressures and under increased pressures. Other investigators have also placed hydrocarbon oils within closed vessels and have heated these oils to high temperatures under such conditions. In such work, Engler, in particular, has made notable contributions to our knowledge of the behavior of hydrocarbons under high temperature and pressure. In these experiments it has been noted that the hydrocarbons have been broken down to lighter hydrocarbons, and that in this way low-boiling oils could be made from hydrocarbons of high boiling-point. Apparently, however, the remarkable influence which is played by the ratio of the liquid contents of the vessel to the total volume of the vessel, has been either wholly overlooked or at least not properly appreciated. It has been through the investigation of the effect of the ratio of the volume of oil to the total volume of the vessel, that I have developed the process which I am here describing. I believe it is only when these suitable volume relationships are observed that we can get these results within a range of temperature and pressure adapted to commercial development.

Studies made in my laboratory have proved that when a vessel is filled to more than one-tenth and less than one-half of its volume with a hydrocarbon body such as gas-oil, and then heated until a pressure of 800 lb. per sq. in. exists within the vessel, a fundamental change occurs in the hydrocarbon. It is as though the carbon and hydrogen atoms were free to rearrange themselves, such rearrangement continuing until a more or less definite mixture of hydrocarbons remains in the vessel. When less than one-tenth of the vessel is filled with oil considerable 'cracking' seems to take place and the product is inferior. When the vessel is much more than one-half filled with oil the reaction seems to fail almost wholly, the amount of light product produced being very small. But when the conditions within the vessel, as to amount of filling, and temperature applied, are as indicated above, the carbon and hydrogen atoms of the hydrocarbon seem to rearrange themselves to form crude-oil and natural gas.

In this rearrangement, not only are low-boiling compounds produced from those of higher boiling-point, but the reverse action also takes place. In several tests I have obtained from petroleum products of medium boiling-point synthetic crude-oils which contained high-boiling ends, whose boiling-point was considerably higher than that of any of the constituents present in the original oil used. Apparently the entire process depends upon certain equilibrium reactions, in which constituents of different boiling-points tend to be present in a certain definite ratio, provided the space relationship within the treating vessel is favorable. Solid paraffin contains no constituents that are liquid or

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gaseous at ordinary temperatures, but upon treatment by this process even this solid paraffin is resolved into synthetic crude-oil and natural gas, and the percentage of products of each definite boiling-point appear to be in a definite condition of equilibrium. If instead of starting with paraffin we go to the other extreme, and start with kerosene which is entirely free from heavy ends, we will obtain a synthetic crude-oil that is much lighter in gravity than that produced from paraffin, but which nevertheless contains high-boiling constituents whose boiling-point exceeds by many degrees the boiling-point of the heaviest product present in the untreated kerosene. Thus it will be seen that while this process is primarily one in which heavy hydrocarbons give crude-oils containing light distillates (this being the main trend of the reaction), yet the process is so dependent upon equilibrium that if high-boiling constituents are absent, or present in very small amount, the equilibrium will not be satisfied until additional amounts of these high-boiling constituents have been produced as the result of the reaction that takes place.

A residual pressure, after cooling, always exists, due to the natural gas formed in the process, and the amount of this natural gas, like the amount of gasoline in the synthetic crude-oil, seems to be constant no matter what hydrocarbon is taken. It is evident to the chemist that natural gas and gasoline contain a greater proportion of hydrogen than do heavier oils, and it is interesting to note that when the charge that is placed within the treating-vessel contains a hydrocarbon deficient in hydrogen, the formation of saturated gasoline goes on just the same, and the synthetic crude-oil produced contains a residual deposit consisting of the carbon that in the rearrangement has failed to find hydrogen. The gasoline produced from materials deficient in hydrogen is quite normal in color, and does not appear to be in any way like the 'cracked' products which are produced by the thermolysis of oil vapors.

The following results of runs made by this process, in one case starting with solid paraffin-wax, and in the other case with Oklahoma gas-oil, illustrate the technical features of the method:

Test 1. Material used, solid white paraffin. Melting point, approximately 120°F. (50°C.). Specific gravity, 0.925 (21.5 Baumé); 300 c.c. taken. Capacity of treating vessel used, 1100 c.c. Heated until pressure of 800 lb. was indicated, then cooled. Pressure of residual natural gas, 130 lb. Product after treatment, a heavy liquid, resembling 'Franklin Heavy' Pennsylvania crude-oil. Color, dark green by reflected light, deep red-brown by transmitted light. Volume of synthetic crude-oil obtained as result of run, 305 c.c. (5 c.c. increase in volume over the amount of liquid paraffin started with). Specific gravity of this synthetic crude-oil, 0.770 (51.8 Baumé). Gasoline yield, on distilling this synthetic crude-oil to 150°C., 48 c.c. Gasoline in synthetic crude-oil, 16%. Specific gravity of this gasoline, 0.70 (70 Baumé). Color, water-white.

Test 2. Material used, Oklahoma gas-oil. Specific gravity, 0.850 (34.5 Baumé); 300 c.c. taken. Capacity of treating vessel used, 1100 c.c. Heated until pressure of 800 lb. was indicated, then cooled. Pressure of residual natural gas, 120 lb. Product after treatment, a liquid resembling Pennsylvania mixed pipe-line crude. Color, dark green by reflected light, deep red-brown by transmitted light. Volume of synthetic crude-oil obtained as result of run, 288 c.c. Specific gravity of synthetic crude-oil, 0.831 (38.5 Baumé). Gasoline yield on distilling synthetic crude-oil to 150°C., 40.8 c.c. Specific gravity of gasoline, 0.705 (68.5 Baumé). Gasoline in synthetic crude-oil, 13.6%. Color, water-white.

It is of course evident that if putting any hydrocarbon through the process described makes it into a crude-oil, it ought to be possible to take any hydrocarbon, convert it into crude-oil by the process described, then remove the gasoline, or any other constituent, from this crude-oil by distillation, and then to subject the residue to a repetition of the process. I have done this many times, and have converted paraffin and other petroleum products almost wholly into gasoline and natural gas. I have obtained from paraffin about 70% of water-white gasoline, the remaining 30% representing the natural gas formed by the repeated action of the process, and some free carbon. From fuel-oil, gas-oil, vaseline, and similar materials, I have obtained from 50 to 70% of water-white gasoline, and samples of this gasoline, even after standing for a year or two, do not discolor, nor acquire an offensive or 'cracked' odor. I wish particularly to note that this gasoline, even when produced, was not treated in any way, and has never come in contact with either acid, alkali, fuller's earth, bone-black, or other related materials. In brief, the process which I have described produced, from practically any hydrocarbon, a material resembling natural crude-oil, and which gives a gasoline which appears equal in quality and appearance to gasoline produced from natural crude. Both the crude-oil produced by this process and the gasoline produced from its distillation possess an odor which is somewhat different from the odor of natural crude-oil and ordinary gasoline. This odor, while peculiar and distinctive, is not in the slightest like the odor of 'cracked' products, and is in fact a slightly milder and sweeter odor than that of ordinary oil products. Upon mixing this synthetic crude-oil, or the gasoline produced from it, with certain muds and clays, it seems to be altered, and the odor changes and becomes more like that of ordinary crude-oil. I am of the belief that crude-oil in nature has in some cases been produced by some process related to that which I have here described, the effect of the high temperature acting for a short time having been produced by much lower temperatures acting through geological ages. I believe the condition that in the retort is represented by about three-fourths open space, in nature has had its equivalent in the open space in the sand or other porous rock which has been the repository of the oil, and that natural gas, which is so commonly associated with petroleum deposits, has

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had a related origin in nature to that which it has in the process worked out in my laboratory experiments.

The study of the genesis of petroleum is so involved that I do not wish these suggestions to be taken in any way as other than ideas which have forced themselves on my mind after noting the similarity in appearance and constitution which exist in most of the petroleums of the world, except where a porous cover or other conditions have allowed the more volatile materials to vaporize, or permitted oxidation or other phenomena to take place. It seems probable that any process which in the laboratory will produce materials of such similar appearance and composition from raw products of the most diverse nature, must surely have some connection with the conditions which in geological time have similarly produced, from products of many different kinds, a material possessing such well-marked and easily recognized characteristics as petroleum.

One interesting development in connection with this work has been the effect of small amounts of certain catalytic materials in facilitating the transformation into synthetic crude-oil. The addition, to the oil to be treated, of even a minute amount of colloidal graphite reduces materially the temperature and pressure at which the process is operative. In one set of experiments, in which a given treating-vessel gave synthetic crude-oil at an average pressure of 850 lb., it was found that the addition of a small amount of finely-divided graphite would permit the pressure to be lowered to 750 lb., or even to 700 lb., on somewhat longer treatment. This seems to offer confirmation of the theory that the entire process is dependent on certain reversible reactions which under the described conditions reach an equilibrium when sufficient time is given. The action of finely divided catalytic materials in increasing the speed of reactions is well known, and in these experiments their function seems to be mainly the increasing of the rapidity of the equilibrium reactions, so that the reaction continues more nearly to completion in the brief time of the test. In my experiments the general procedure has been to heat the treating-vessel until the desired pressure is indicated, when the heating is stopped, and the treating-vessel cooled and emptied. When, instead of raising the pressure to the desired treating maximum, and instantly cooling the vessel, we raise it to a somewhat lower temperature, and maintain this temperature for 5 or 10 minutes, we get practically an equivalent result. Where a catalyst is used, as described, it is possible to use a much lower pressure and still obtain a normal synthetic crude-oil.

The experiments that I have described have been wholly of a laboratory nature, and much work remains to be done in the application of the principles that have been discovered to commercial work on a large scale. While it may seem that the pressures and temperatures employed are so high as to preclude the possibilities of commercial work, yet I do not think this is the case. Processes have been developed abroad, during the past few years, in which ammonia is made synthetically by reactions requiring both higher pressures and higher temperatures than those which are made use of in my present work. As these ammonia researches have progressed from their laboratory inception to their commercial development upon an extensive and successful scale, I believe the present process will find similar development comparatively easy. The conditions necessary for successful commercial work are already well known, and involve no engineering features which American ingenuity cannot easily provide, and it is my hope that this process will be soon developed to the point where it will fulfil commercially the remarkable promise that it now seems to offer.

A HANDBOOK OF THE COAST AND GEODETIC SURVEY

The Department of Commerce has issued for distribution at the Panama-Pacific International Exposition a pamphlet entitled 'United States Coast and Geodetic Survey, Description of its Work, Methods, and Organization.' While this work is intended for the general reader, it also gives a concise account of the more important scientific features of the work of the Survey and of the improvements that have been made in recent years in instruments and methods. In the section relating to hydrography there is a description of the wire drag, a valuable apparatus for discovering hidden dangers from rocks that escape detection by the ordinary method of sounding. In the section relating to tides is a brief description of the improved tide-predicting machine, which with one operator predicts the tides for one year in advance for any port, and does the work of 100 men. To set the machine for any station and tabulate the tides for a year for any port takes not more than 12 hours. In the article on base lines there is a description of the modern method of measurement with tapes of invar metal now used in the Survey to the exclusion of any other method. The invar metal is an alloy of nickel and steel, the advantage of which for this and many other purposes is that its rate of expansion and contraction under changes of temperature is about one twenty-fifth that of steel, so that the important source of error due to temperature changes is practically eliminated. The use of these tapes has decreased the cost of base measurement by about 35% and greatly increased the rapidity of the work. Under the head of astronomy is a description of the Talcott method of observing latitude by means of which results of superior accuracy are attained. This method has long been used by the Survey in precise determinations. The instruments used in the determination of longitude by the telegraphic method are also described. The use of a motor truck for the transportation of parties engaged in latitude work is mentioned as having increased the rapidity and decreased the cost of such work considerably. While the work of the ordinary surveyor does not require similar accuracy, much can be learned from a comparison of methods.

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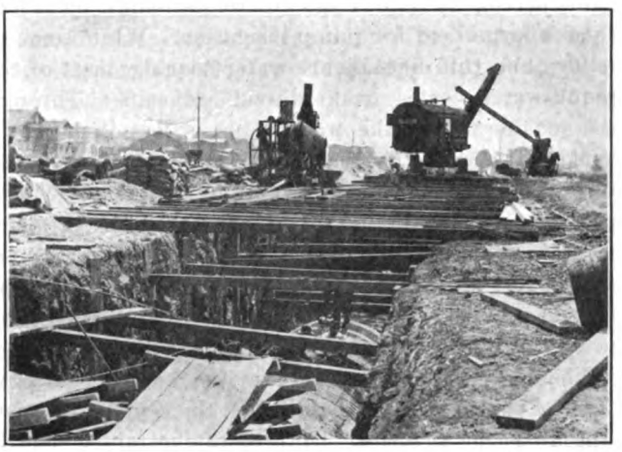
The Arroyo de La Brea Storm Sewer

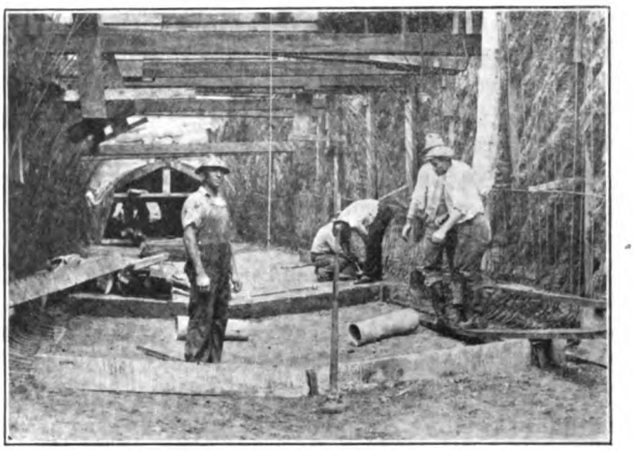
By W. C. SAWYER*

The city of Los Angeles is engaged upon the design and construction of a very comprehensive and adequate system of storm-sewers. Small units have been built in past years, where imperative, although sometimes not in accord with a general system. Within the last two years, however, the people have awakened to the desirability and economy of constructing large drains ahead of other street improvements. There has recently been completed one large unit known as the Arroyo de La Brea storm-sewer system, named from the natural waterway which it in part displaces and into which it for the time empties. The system is now in satisfactory operation, although its success is apparently somewhat lessened because considerable water which later will be collected by another larger unit known as the Arroyo de La Sacatela, is now discharged through the present system. The sewer was designed under the immediate direction of E. A. Tuttle, Homer Hamlin being city engineer. The construction was done by James Kennedy, who used more adequate equipment than some former contractors.



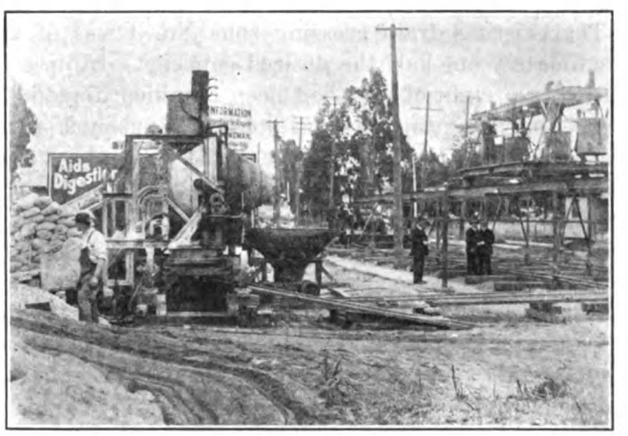
BUILDING PIPE IN TRENCH BEHIND STEAM-SHOVEL.

At the lower end of the main line, 4600 ft. of reinforced-concrete sewer with arched top was laid. The excavation was done with a revolving Marion shovel, model 36, having a long-handled dipper. The dirt was hauled to cover and spoil banks in two-horse dump-wagons. The shovel rested upon heavy timber supports laid across the excavated trench. When the shovel was moved forward the timbers were handled by hanging them to the dipper with chains and swinging a section at a time from the rear to the front of the shovel. Immediately adjoining the arched section was 600 ft. of a reinforced-concrete box-section, 8 ft. square, this form being adopted on account of the shallow depth of the sewer at this point. Next to the box section was over 6000 ft. of monolithic concrete sewer with circular interior varying from 5½ to 8½ ft. in diameter. Besides this, 26,700 ft. of reinforced-concrete pipe was used, varying in diameter from 2 to 5 ft. For sizes 23 in. and 3 ft. one ring brick was used, there being about 11,900 ft. of this type of construction; 9500 ft. of vitrified-pipe sewer was laid, the sizes running between 12 and 22 in. In addition there was 9500 ft. of catch-basin connections of vitrified pipe.



PLACING FORMS AND REINFORCING RODS.

With the exception of the steam-shovel work already discussed, nearly all of the excavation was done with Parsons' trenching machines. In the larger trenches they were followed by traveling overhead tramways carrying suspended steel buckets known as Potter machines. The trimming and finishing was done by hand shovelers, who filled these buckets, after which they were raised above the track, hauled by cable to a completed sewer, and dumped in the trench. The con-



CONCRETE MIXER AND POTTER MACHINE.

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tract required, in addition to the work above mentioned, the construction of 324 catch-basins, 137 manholes, and the reconstruction of 2200 ft. of sanitary sewer with 17 manholes. About 180,000 cu. yd. of earth was moved; 17,441 sq. ft. of asphalt paving was required to cover the trenches in paved streets and for remodeling intersections so as to eliminate cross-gutters and culverts and to render drainage to basins effective. The contract price was $662,063.04. Work on the trenches was begun April 25, 1914, and was completed early in the present year. The area included in the assessment district was 2040 acres, although the lower three blocks of the system was designed to carry the water from the Wilton Place system and was organized as a separate district draining 638 acres. Both systems were built in accordance with the Vrooman act.

The Arroyo de La Brea storm-sewer district was divided into zones according to the estimated benefits to be derived. In zone No. 1 the assessment was $0.006646 per sq. ft. of lot area. The low rate in this zone was due to the fact that some of the drains had been planned to be constructed as a part of paving contracts. The price in zone No. 2 was $0.0143636 per sq. ft., the higher assessment being due to extra benefits due to grading. In zone No. 3 the assessment was $0.007696 per sq. ft., being lower on account of an existing drain. In zone No. 4 the benefits were greater on account of the greater existing trouble from water and the filling of the Arroyo thereby enhancing value of property in the vicinity. The assessment was $0.01436 per square foot.

All territory in the district outside the above-mentioned zones was assessed $0.0095755 per square foot. The final settlement may change some of these figures slightly.

The existing drain crossing zone No. 3 was of approximately one-half the desired capacity. In its construction a right-of-way had been obtained diagonally across private property and streets. Inasmuch as it was out of the question to place the new sewer anywhere but in public streets and alleys, seven crossings at grade, and at very small angles in some cases, were required. At these intersections the old pipe was cut and large round or oblong junction-chambers constructed of brick with reinforced-concrete slab tops.

The concrete for the monolithic sewer was mixed in T. L. Smith mixers placed along the trench and was transported to the work in small steel cars having a gate on one side near the bottom. The cars carried one batch and were pushed along a narrow-gauge track by two men. From the cars the concrete was placed by means of jointed steel spouts. As will be seen by the photographs, a section was laid on the bottom a few feet wide and finished to conform to the inside form of the sewer, and the collapsible wooden forms set upon it.

In most cases the earth would stand in the walls of the trenches with little bracing. In some cases it was found possible to excavate the trench only as wide as the excavator buckets and build the brick sewer a few inches outside.

Water difficulties were handled by pumps and drains. Little trouble was experienced on account of interferences with existing underground structures. The reinforced-concrete pipe was made on vacant lots and parking spaces along the route of the sewer by the Western Reinforced Concrete Pipe Company.

GROUND-WATER IN THE SACRAMENTO VALLEY

The opportunities for pump-irrigation in the Sacramento valley are discussed in *Water-Supply Paper* No. 375-A, entitled 'Ground-Water for Irrigation in Sacramento Valley, California,' by Kirk Bryan. While, of the 21,936,325 acres of agricultural land in California, 3,188,541 acres are irrigated, or 14.5%, in the Sacramento valley, out of 3,305,000 acres of agricultural land, only 117,792 acres, or 3.5%, are irrigated. It is estimated, however, that water will eventually be brought to 2,500,000 acres, or 21 times the present area. Much of this acreage will be irrigated from streams, but there is also a large field for pump-irrigation. While some of the lava and tuff deposits are water-bearing, most of the ground-water comes from alluvial deposits. Through most of the valley, the water-table is less than 25 ft. from the surface. The height of the water-table varies considerably during the year, rising after the winter rains and lowering during the summer. In sinking wells, the old method of digging or of boring with a 'post-hole' auger, are slowly giving way to regular drilling, sometimes with a hydraulic outfit, but more often with the churn-drill. The yield of a well is largely dependent on the kind of screen used at the water-strata. As might be expected from the low lift, the centrifugal type of pump is the favorite. Unlined ditches are generally used for the distribution systems, although some ranchers have begun to use cement pipe. In 1913, 40,000 acres were irrigated from wells in various parts of the valley. Except where distance from a power-line makes it impracticable, electric power is preferred for pumping.

SEWAGE AS FERTILIZER

The results of an investigation of the fertilizing value of sewage sludge by Messrs. C. B. Lipman and P. S. Burgess have been published in *Bulletin* No. 251 of the Agricultural Experiment Station of the University of California. Samples of sewage sludge from several California cities and also from some Eastern municipalities showed, on analysis, an average of about 2% of nitrogen. Tests to determine the availability for plant nourishment of the nitrogen contained, showed that the sludge samples compared favorably with samples of commercial fertilizers. A value of approximately $10 per ton for fertilizing purposes was placed upon sewage sludge. In California, it is estimated, that about $100,000 is being lost every year through failure to make use of the fertilizing materials contained in sewage.

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Navigability of the Sacramento River*

By E. G. HOPSON†

If you start from Redding on the north and proceed south to the point where the Sacramento and San Joaquin rivers unite near Collinsville, you pass over about 180 miles measured as the crow flies and through a remarkably level and fertile district, known as the Sacramento valley. In the few words I am proposing to address to you today I find it necessary to limit myself to consideration of problems affecting this great valley. I thus limit myself, not because I consider other parts as in any sense less conspicuous or less important, for this is by no means the case, but because the problems relating to river storage in this great state are so many and so important that it would be foolish to attempt to cover so wide a field in the short time that is available.

Next to the Columbia and the Colorado, the Sacramento is the most important river in the United States that enters the Pacific ocean. The Sacramento has another distinction, which it shares with only two other western rivers, in that it cuts through the main mountain mass of the Cascade range. The Sacramento is considered navigable up to Red Bluff, a total distance of 260 miles above its mouth at Collinsville. The nature and extent of the navigability varies a great deal in the distance of 260 miles. The lower 70 miles, namely, the portion between Sacramento and the river mouth, has a minimum depth of 7 feet. It is traversed by good-sized steamers and is of great importance as a main artery of traffic. The next stretch, between Sacramento and Colusa, is 90 miles long. This is reported to have a minimum depth of 4 ft., although its average depth is much greater. A great deal of freight is handled in this section. Between Colusa and a point opposite Chico, a distance of 50 miles, a considerable volume of traffic passes, although the minimum navigable depth was reported in 1910 as being only 3 feet. The 52 miles from Chico up to Red Bluff is reported as only having from 1½ to 2 ft. minimum depth during six months of the year, and in recent years the traffic on this section has dwindled to insignificant dimensions.

The significant feature of the Sacramento river is that it passes for nearly 300 miles through a fertile territory almost as large as England and Wales, which supports a population of nearly forty millions. England is a rich agricultural country, but it is doubtful if its potential fertility is greater acre for acre than the Sacramento valley. The products of this great valley will at no distant date be multiplied many times. All the arteries of travel will at times be overtaxed in moving the great amount of freight down to tide water for export purposes. This kind of statement seems exaggerated and in a sense foolish at the time, but is, I believe, a thoroughly justifiable conclusion to reach in the light of the possibilities for development known to exist. Now it is important that means of transportation not only for present uses, but also for the greater future requirements should receive earnest consideration from this Congress. We must fix our attention to the conditions of tomorrow and try to anticipate these needs to some extent so that great natural advantages shall not become blocked by obstacles, as a result of disuse or neglect. The question of navigability is one of these matters that call for a wide and far-seeing view.

Irrigation.—The water of the Sacramento river and its tributaries will at no distant date be all used for irrigation during the summer and fall season. The summer flow of the river to about 6000 to 7000 second-feet, or enough to irrigate 600,000 to 700,000 acres of land. The irrigable area of the valley is over 1,500,000 acres, so that all the summer flow of the Sacramento and its various tributaries can be applied to beneficial use in producing the crops on which the future wealth and prosperity of this valley will depend. This water is year by year being taken from the river in increasing amount. It is incumbent on this Congress to face the situation boldly and squarely and attempt to formulate some logical line of policy on which our action will be based during the years that will elapse before anything like full development shall be consummated.

No sane person in this or any other California audience would presume to say that the agricultural development of this great region on which the prosperity of nearly one-half of the state will rest shall be hampered by the consideration of only one of the means whereby the product can be carried to the markets. Should we be forced to make a choice between developing farms and orchards or developing the upper river navigation, there could be but one answer—to develop the farms. I believe that the opportunities for water storage in the mountain region around the valley are sufficient to furnish the necessary irrigation supply without consuming the last drop from our rivers. There are possibilities for building reservoirs of great capacity on the upper Sacramento and Pitt rivers as well as the Feather and other tributaries. If these and other reservoirs not yet surveyed were developed, affording perhaps as much as 3,000,000 acre-feet of storage, this amount used in conjunction with the great underground supplies that can be tapped by pumps would in all probability enable us to leave the summer flow in the main stream untouched, should such a policy seem advisable.

*Address delivered at the Congress of the Inland Waterways Association of California, San Francisco, March 23-25, 1915.

†Engineer, U. S. Reclamation Service, Portland, Oregon.

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All of this is largely a question of cost. What is the storage going to cost and what is the navigability of the upper river worth? To allow the low water flow of the river to be preserved unimpaired, a storage capacity of about 1,500,000 acre-feet would be necessary at a probable expenditure of $15,000,000, certainly a large sum for this purpose. It is probable that the upper river could be completely canalized for not more than $10,000,000. This would permit more satisfactory navigation conditions than in the ordinary unimproved river channel with its shifting stream bed, swift current, and uncertain depth. The adoption of a policy of canalization for upper river navigation would substantially relieve irrigation development of a burden that now retards its progress to a marked degree, and is to be recommended to this Congress for consideration.

Flood Control.—Closely linked with the question of navigation is that of flood control. The great plan of flood control and reclamation of bottom-land in the Sacramento and San Joaquin valleys that has been adopted by the state is a part of the general plan of improvement of the navigability of these two rivers that has been recommended to Congress by the Army engineers that are in control of navigation projects. This work of reclamation of bottom-land from floods and the improvement of navigability of the river that may be expected as a direct result of the regulation of flood waters are both closely associated with the problems of storage and irrigation. In fact, in this region the problems of each of these different lines of development are much the same.

Navigability of the rivers is improved and maintained by control of floods. The same works that control the floods permit the reclamation of 700,000 acres of bottom-land, some of the richest in the state. Again the land when reclaimed from overflow requires irrigation, and the same works that can store the irrigation supply will hold back much of the flood water that would otherwise devastate this land. To complete the illustration, the thorough reclamation of this bottom-land will call for the development of hydro-electric power for pumping and irrigation purposes. This can also be advantageously furnished by the very works that serve to furnish both irrigation supplies and flood protection. In other words, flood control, water storage, navigation, and irrigation in the Sacramento valley go hand in hand to a great extent, owing to the unusual opportunities that nature affords.

Policy.—Now what I suggest for this Congress to work for is the outlining of a comprehensive policy, in a manner to yield the greatest benefit to the greatest number and not to satisfy the idiosyncrasies of the few. This policy will necessarily be largely administered by the new water commission, but its direction should be indicated clearly by the people, and such organizations as this are largely the mouthpieces of the people in these specialized affairs. You should, in your consideration of the different phases of development now pending, attempt also to picture what the conditions will be in twenty or fifty years hence, and determine how your state water commission shall proceed to regulate developments, so that these will be in harmony with a system conceived in the interest of all. My suggestions as to some principles that I believe this Congress should adopt, and endeavor to induce the State and Federal government to adopt, are:

(1) The radical improvement of navigability between Sacramento and the mouth of the river, so that the 35 ft. of depth which it is proposed to secure by dredging in the channel between Rio Vista and Collinsville will be extended up to the capital, in order that ocean-going ships of deep draft can pass at all times.

(2) The continued improvement of the navigable channels of the Sacramento and Feather rivers by dredging, snagging, the building of wing-dams, or such other means as appear appropriate and desirable to protect navigation interests under present conditions. These measures should, however, be carried out in such manner as to provide for the gradual utilization of the water for irrigation purposes and should be supplemented by plans of canalization to be taken up step by step as irrigation uses develop and the requirements of navigation become apparent.

(3) That reservoirs carefully located at the headwaters are of the highest importance in the development and improvement of inland waterways, not only for possible regulation of flood peaks and the protection of navigable channels and reclaimed lowlands, but for the conservation of summer irrigation supplies whereby the water now available for navigation may remain so without interference with the agricultural necessities of the valley.

MAGNESIAN CEMENT

In Volume I, No. 3, of the University of California publications in engineering, Arthur C. Alvarez discusses the physical properties of magnesian cement mortars and concretes. The comparative rarity of magnesite deposits, the only important ones in the United States being in California, render it certain that magnesian cement products can never come into serious competition with those of portland cement, although it is possible that they might be produced at a somewhat lower cost. Magnesian cement is used principally in the production of artificial building stone for interior trim and flooring. For this purpose it is cheaper than marble, but does not possess the lasting ornamental appearance of marble. Magnesian cement products are too absorptive of water for use on exterior work. They are not fire-resistant. A mixture of one part cement to four of sand has about the same fire-resistant qualities as marble; leaner mixtures are proportionately less resistant. For like proportions by weight, and for the same age and consistency, magnesian cement concretes are about 40% stronger than portland cement concretes.

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Increasing the Capacity of Oil-Fired Babcock & Wilcox Boilers

By J. E. WOODBRIDGE*

This article describes an attempt to increase the capacity of oil-fired boilers by the removal of the bridge-wall and the consequent extension of the furnace length to the entire length of the boiler, and gives results of tests on the capacity and efficiency of boilers so equipped.

Before the opening of the Panama-Pacific International Exposition, the Sierra & San Francisco Power Company overhauled the older sections of the boiler equipment of its North Beach steam reserve power-plant, in San Francisco, in order to reduce smoke when this power-house is forced heavily, as it is in an emergency. This was advisable as the power-house is surrounded on the land side by the grounds of the Exposition. Part of the old boiler equipment consists of eight Babcock & Wilcox boilers set in batteries of two, each boiler consisting of 12 rows each of twenty-one 4-in. tubes, 18 ft. long, with inclined headers and three drums without superheaters, and with a rated heating surface of 5020 square feet. Originally these boilers had the usual furnace arrangement with three Hamel furnaces and Peabody backshot burners for each boiler, air being admitted through the ash-pit doors above the boiler-room floor line, thence through checkerwork approximately three feet long on pipe supports. The original furnaces were 8 ft. long from the front wall to the fire-wall, and 4 ft. 4½ in. high at the front.

These boilers smoked considerably when forced materially above rated load, and it was recognized that longer and deeper furnaces and less constriction of ingoing air would improve combustion under forced firing. The furnaces of six of these eight boilers, constituting three batteries, were rebuilt with the fire-wall moved back 2 ft. and the furnace-floor dropped as far as possible, namely, 6 in., with the length of the checkerwork increased to 4 ft. 6 in. As the boiler foundations had been built in a high basement with provision for ash handling in case coal should ever supersede oil in this region, additional access for draft was provided from the basement with dampers having mechanical control from the boiler fronts.

While this work was under way, M. H. Brondsen suggested that the bridge-walls be omitted altogether and that the burners be made long enough to shoot clear from the back ends of the boilers near the mud drums. This suggestion was followed in the case of the last two boilers re-equipped, which are referred to in the tables below as No. 1 and 2; No. 3 to 8 inclusive having the conventional bridge-wall with 10-ft. furnaces as above described. The arrangement of the furnaces in boilers No. 1 and 2 is illustrated in the accompanying vertical section, which also shows the provision made for supporting the furnace-floors and checker-brick by means of grate bars, the arrangement of the baffles, and the experimental and temporary provision of wooden doors and dampers in the basement openings through which a large part of the draft is provided. The position of the original furnace-floor and of the front face of fire-wall is shown by dot and dash lines. The vertical baffle between the first and second pass, originally above the fire-wall, was left as before, and additional baffle-brick was placed around the lower row of tubes, as shown, the baffle-brick under the first pass being provided to throw the products of combustion clear to the front wall of the furnace, but with their ends cut away in such a fashion as to allow some of the hot gases to pass up the rear portion of the first pass.

The firebrick used on the lower row of tubes was inverted 'T' brick intended to enclose the tubes on the lower side, to protect them from the flame and to give a white-hot furnace similar to that of a bridge-wall with a coal fire, with the idea of improving combustion. As the material used broke away below the lower row of tubes, this object was not attained, but no harm has resulted to the tubes in considerable forced firing, and the baffles otherwise have not burned above the usual rate. Another grade of material might have remained in place below the lower tubes.

The vertical baffle between the second and third pass, not shown in the drawing, was raised in such a way as to give free passage for the gases above the lowest row of tubes. It will be noted that these changes gave the boilers a furnace length of approximately 16 ft., a dimension of 14 ft. from the burner to the front wall, and an increased depth of furnace of 6 in. at the front. A greater depth would probably have been advantageous, but it was obviously impracticable. The length of checker-brick was increased by this change from 3 to 6 ft., and the provision of air from the basement cut out the restriction in the ash-pit doors.

No reliable tests are on record of the capacities or efficiencies of these boilers previous to the change, but since the change has been made the boilers have been tested by the use of a meter in the fuel-oil line and a General Electric, type TW2, portable water-flow meter in the boiler-feed lines. The results of these tests are shown in Fig. 1.

In all cases the overload was limited to that which could be obtained with only a thin straw-colored smoke. Boilers No. 1 and 2 are at the end of the line farthest removed from the stack. In general, throughout these tests the boiler under test provided practically all the steam necessary for the operation

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Boiler Number	Time to Raise steam	Oil Consumed to Raise Steam (Bbl.)	Duration of Test	Number of Burners	Furnace Length	Rated hp.	H. P. Developed 34½-lb. from and at 212° F.	Rating %	Lb. of water From & at 212°F. per lb. of oil as fired	Draft at Bottom of 2nd. pass	CO_2	O	CO	Oil Temp.
1	25 min.	3½	1 Hr. 16 M.	3	16 ft.	500	1107	221	11.7	3/16-in	13.6	1.4	1.6	165 Degrees
2	30 "	3½	1 " 5 "	3	16 ft.	500	958	191	12.4	"	12.4	2.8	0.8	"
2	22 "	2½	1 " 42 "	3	16 ft.	500	1081	216	12.9	"	14.1	0.5	0.8	"
1	25 "	3½	2 " 35 "	3	16 ft.	500	1169	234	13.3	1/8-in	13.0	0.8	0.5	"
3	40 "	4-1/3	1 "	3	10 ft.	500	790	158	12.5	3/16-in	12.2	0.8	1.6	"
3	previously on load		2 "	3	10 ft.	500	1023	204	12.4	"	13.2	1.1	0.6	"
4	37 min.	4-1/4	1 " 15 "	3	10 ft.	500	906	181	12.8	"	13.6	0.9	0.7	"
4	previously on load		1 " 15 "	3	10 ft.	500	969	194	12.5	"	14.1	1.1	1.1	"
13	27 min.	4	1 " 10 "	4	8 ft.	600	830	138	11.7	1/4-in	11.7	1.0	1.0	"
13	previously on load		50 "	4	8 ft.	600	915	152	14.0	"	13.2	1.0	0.8	"
14	28 min.	3-3/4	1 " 10 "	4	8 ft.	600	970	161	13.7	"	13.7	0.7	0.5	"
14	previously on load		40 "	4	8 ft.	600	1058	176	14.7	3/16-in				
15	" " "		1 " 45 "	3	10 ft.	600	1111	185	14.1	1/4-in	13.9	1.0	0.4	200

FIG. 1. RESULTS OF TESTS, NOT CORRECTED FOR MOISTURE CARRIED OVER BY STEAM.

of the plant, which was floating on the system over the evening peak. The draft was therefore not as high as it might have been. As the boilers were not fired continuously and in most cases were brought up from a cold or practically cold condition in the time shown, the settings were not so hot nor the efficiency so high as they would have been under continuous load. The results, however, give a basis for comparison between the different types of furnace for the conditions which are normal in this plant. For comparison, the results of tests under similar conditions of boilers No. 13, 14, and 15 are given. Numbers 13 and 14 are 21 ft. wide by 14 ft. high, with four burners and with furnaces 8 ft. long. Number 15 is sim-

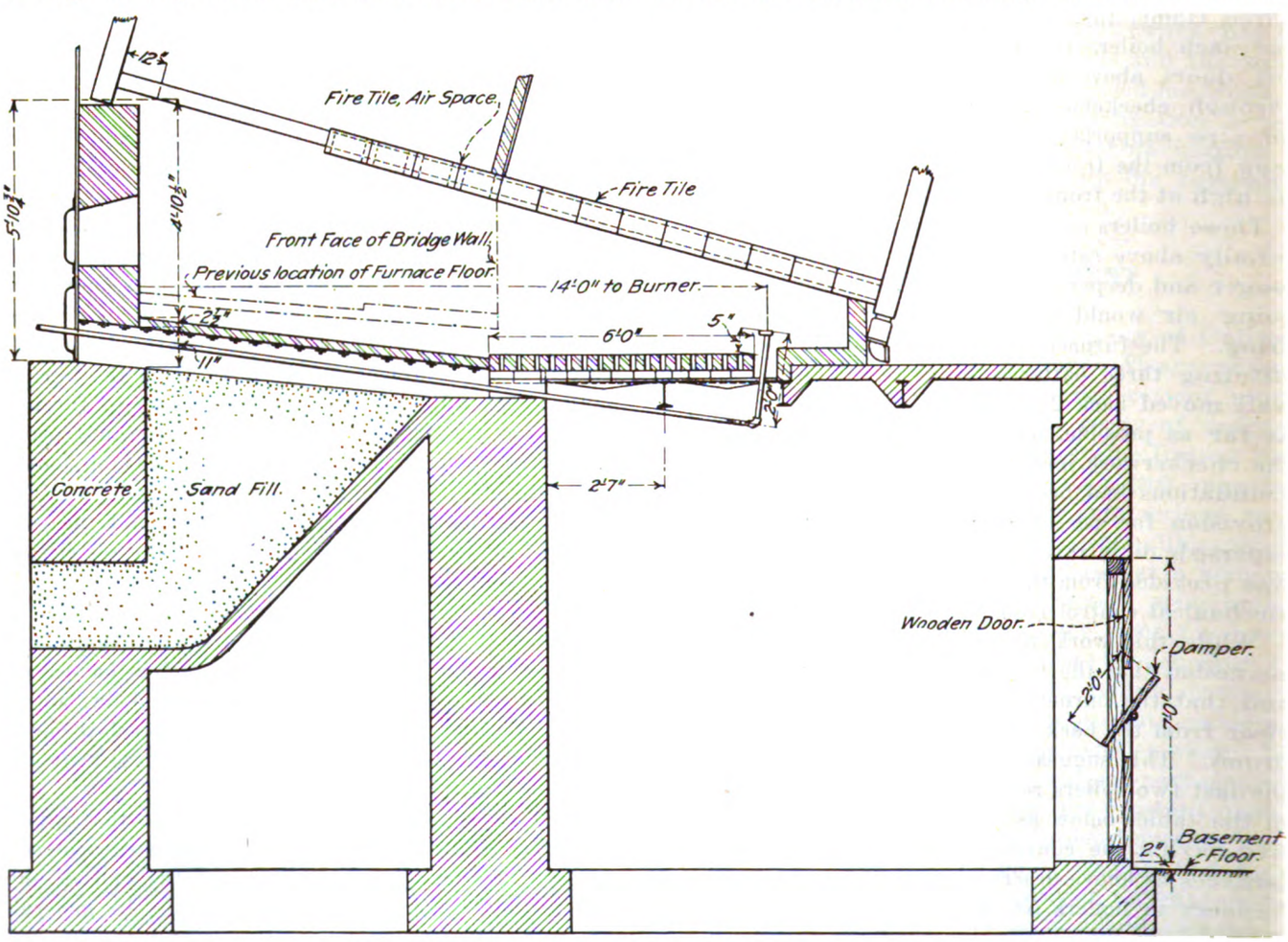

FIG. 2. BOILER SETTING AFTER BRIDGE-WALL WAS REMOVED.

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ilar to No. 13 and 14, but has three burners, a furnace 10 ft. long by 5 ft. 8 in. high, and, in addition, a single-loop superheater.

The average results of No. 1 and 2, 3 and 4, and 13 and 14 may be compared as follows:

No.	% of rating.	Lb. of water per lb. of oil.	CO_2.
1 and 2	227	12.4	13.3
3 and 4	185	11.8	13.3
13 and 14	157	12.8	12.9

It is apparent from the above rather rough tests that the capacity of the boilers was increased approximately 23% by lengthening the furnace from 10 to 16 ft.; also that the efficiency was improved somewhat at this capacity. It is the writer's belief that the firemen became better accustomed to handling the dampers under test conditions as the tests proceeded, giving No. 3 and 4 an advantage, and that the comparative efficiency of the long furnace is somewhat better than that shown. The bridge-wall in oil-fired Babcock & Wilcox boilers appears to be a worse than useless survival of coal-fire practice.

Tests of Melting Points of Cast-Iron Tubes

By R. F. CHEVALIER*

Tests were made on several cast iron tubes to determine the maximum temperature which they would withstand before deflection, breaking, blistering, or melting occurred.

Tubes Tested.—Two tubes of cast iron, especially prepared to withstand high temperature, were submitted by an Eastern manufacturer. These will be called Cast Iron 'A.' The tubes were 30 in. long with a diameter of two and four inches, respectively, and an average thickness of walls of one inch. As these tubes failed at a comparatively low temperature, other tubes manufactured in local foundries were obtained. One of ordinary good grade cast iron, which will be designated as Cast Iron 'B', had the following dimensions: length, 26 in.; inside diameter, 5 in.; average thickness of wall, ½ in. The other was manufactured by P. David company, and was processed to withstand high temperatures more successfully than could be expected from cast iron not thus treated. This will be designated as Cast Iron 'C.' The dimensions of this tube were: length, 30 in.; inside diameter, 2¾ in.; outside diameter, 4¾ in.; average thickness of walls, 1 in.; minimum, ⅞ in.; maximum, 1⅛ inches.

The tubes were placed in the furnace in a horizontal position and supported at both ends on brick piers. The distance between the points of support was 24 in. The furnace was designed to secure uniform distribution of temperature. Crude oil was used as fuel and atomized with low-pressure air. The general arrangement of burner and furnace was such that the flames did not impinge upon the tubes until they were subjected to the maximum temperature. The initial temperature to which the tubes were subjected was not sufficient to cause any physical change. The temperature of the furnace was gradually increased and was maintained as nearly constant as practical at various temperatures for a sufficient length of time to note the effect on the tubes before again increasing the temperature. Temperature measurements were made with a standardized Taylor thermo-electric pyrometer, using a Platinum, Platinum-Rhodium Thermo-couple. The end of the couple was located in front of and between the tubes. During the test of August 9 a Fery's radiation pyrometer was used to check the temperature of the melting-point of the metal.

Data and Results.—The data obtained are tabulated below. The figures in the temperature column designate the temperature of the gases surrounding the tubes. All temperatures are in degrees Fahrenheit.

Test of Cast Iron 'A' Tubes.—August 7, 1913

Time.	Temperature.	Remarks.
12:55 p.m.		Fire started.
1:25		Fire increased.
1:40	1880°	Both tubes showing deflection.
1:51		Small tube broke in two near centre. Fire reduced.
2:10	1740°	
3:20	1800°	
3:22		Fire extinguished to take note of condition of tube. No change in tube other than deflection above noted.
3:23		Fire relit.
3:30	1900°	
3:45	1900°	Large tube broke.
3:50		Fire increased to note effect of higher temperature.
4:00	2400°	
4:45	2550°	
4:46		Fire extinguished. Tubes completely melted.

Test of Cast Iron 'B' and 'C' Tubes.—August 9, 1913

Time.	Temperature. Pl. Pl. Rh. Couple.	Remarks.
1:00 p.m.		Started fire.
1:10	1080°	
1:30	1300°	Fire decreased.
1:40	1240°	
1:48		Pyrometer couple changed to front of lower tube.
3:00	1375°	
3:01		Fire out to examine tubes for deflection. None had occurred.
3:15		Fire started.

*Consulting Engineer, Merchants Exchange Building, San Francisco.

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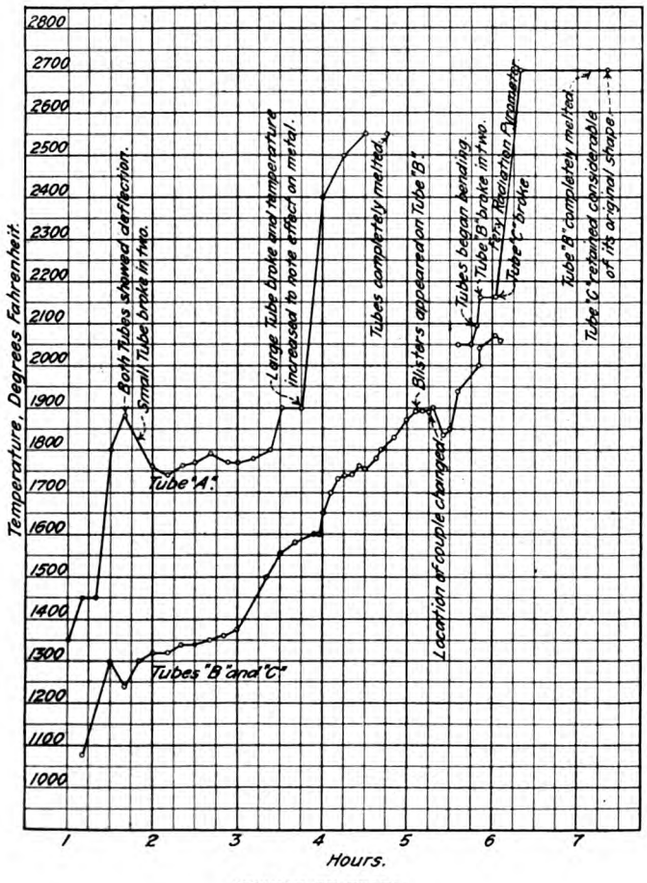
Time.	Temperature. Pl. Pl. Rh. Couple.		Remarks.
3:20	1500°		
3:55	1600°		
3:58			Fire increased.
5:00	1880°		Blisters ¾ in. to 1 in. diameter appearing on bottom of cast iron 'B' tube.
5:15	1890°		Fery radiation pyrometer used focused on spot on 'B' tube where blisters are occurring.
		Temp. Fery Pyro.	
5:20	1900°	1980°	
5:24			Raised Pl. Pl. Rh. couple to a position 1½ in. above lower part of upper tube.
5:30	1850°	1980°	
5:32			Fire increased.
5:45	1980°	2050°	Tube bowing.
5:50	2000°	2100°	Metal in bottom of 'B' tube melting.
5:51		2150°	'B' tube broke in two. 'C' tube remaining.
5:52			Fires increased.
5:53	2040°	2160°	Fery's pyrometer sighted on lower part of 'C' tube.
6:00			Blisters appearing on lower portion of 'C' tube.
6:05	2070°	2160°	
6:08	2060°		'C' tube broke in two.

At 6:20 p.m. the fire was increased so that the broken pieces of tubes were subjected to a temperature of 2700° Fahrenheit. The fire was extinguished at 7:20 p.m.


Temperature, Degrees Fahrenheit.
Hours.
Both Tubes showed deflection.
Small Tube broke in two.
Tube "A."
Large Tube broke and temperature increased to note effect on metal.
Tubes completely melted.
Blisters appeared on Tube "B."
Location of couple changed.
Tubes began bending.
Tube "B" broke in two.
Fery Radiation Pyrometer.
Tube "C" broke.
Tube "B" completely melted.
Tube "C" retained considerable of its original shape.
Tubes "B" and "C"

RESULT OF TESTS.

Condition of Tubes After Experiment.—On August 11, the tubes were removed from the furnace. The cast iron 'B' tube was melted into a flat shapeless mass, the metal having oxidized considerably. The tube manufactured by P. David Company, cast iron 'C,' was in two pieces. One-half retained its original form. The other had collapsed lengthwise but retained considerable of its original shape. In places, the metal had melted and run, leaving a thin shell on the out and inside surfaces, indicating that some process had been used for treating the surfaces to resist the effect of higher temperatures.

Summary.—The cast iron 'A' tube started to deflect at 1880° Fahrenheit when the small tube lost its tensile strength and broke. The large cast iron 'A' tube broke in two at 1908° Fahrenheit. The metal melted and oxidized at a temperature below 2550° Fahrenheit. With the 'B' tube, small blisters appeared on surface at 1950° Fahrenheit. The tube started to deflect at 2050° Fahrenheit. The metal started to melt at 2100° Fahrenheit. The tube broke at 2150° Fahrenheit. The 'C' tube started to bow at 2050° Fahrenheit. Blisters appeared on the surface at 2160° Fahrenheit. The tube broke at 2160° Fahrenheit. The metal showed no signs of melting before breaking. After being subjected to a temperature of 2700° Fahrenheit for an hour, the pieces still retained considerable of their original shape.

A cableway of novel design for ferrying automobiles or other vehicles across the Gila river has recently been put in service at Gila, N. M. It consists of two flat steel ropes each ½ by 5 in. in cross section, spaced 8 ft. apart and having a main span of 340 ft. The cables are anchored to deadmen buried in the river bed, and pass over 12 by 14 in. timber piers 14 ft. above the bed of the stream. Each cable is 670 ft. long, the additional length being required in order to reach ground suitable for the deadmen. The slack in the secondary span between piers and anchorages is taken up by heavy stone counterweights. Four double-flanged wheels 1 foot in diameter run on the cables, and from them is suspended a platform built upon two I-beams 18 ft. long and 6 in. deep, designed to carry 20,000 lb. The frame joining the double-flanged wheels connects with an endless cable ⅝ in. in diameter, which runs over 30 in. vertical sheaves at either shore and passes around a 72-in. horizontal drum at one end, to which is attached a horse-sweep. The car usually makes the trip from landing to landing in about 3 minutes. The maximum load normally carried is 10,000 lb., although when the cable was completed a load of 20,000 lb. was carried across to test the bolts and deadmen. The cables have a breaking strength of about 120,000 pounds. A cableway of this kind should be of use at many places where the traffic is considerable, but does not justify a bridge. —*Engineering News.*

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Reinforced-Concrete Tile*

By W. J. SCHLICK†

If an historian should make a study of underdrainage, the present decade would undoubtedly stand out pre-eminently as a period of development; a period during which methods based on some 'rule of thumb' have given way to other methods that are the result of careful study and investigation and which are based upon accurate scientific principles. The rapid advance in the value of farm lands has not only made possible, but has demanded, more careful drainage work in larger and more efficient systems. A few years ago one tile system drained a few acres or a part of one section. Now one system will serve several sections. This increase in the size of the systems has required the use of tile of larger size. Many large underdrainage systems constructed a few years ago had open ditches for outlets. The increase in the value of farm lands and crops has now made it economically advisable to substitute the large tile outlet for these open ditches. It has not been many years since the engineer who planned a drainage system in which 30-in. tile was to be used was thought to be visionary. Now, almost every engineering paper contains notices that this or that drainage district is ready to receive bids for the construction of drainage systems in which 34-in., 36-in., and even 44-in. tile is to be used.

With the use of tile of large sizes has come the practice of placing these outlet mains at greater depths. Frequently some distant portion of the district is low and the main must be placed at a great depth in order to furnish a suitable outlet. Often it is found that it will be cheaper to lay a large main at a greater depth through a ridge than to construct a longer but shallower line around the low ground. The writer has knowledge of drains laid at depths as great as 20 ft., while large tile, of 18 in. diameter and larger, laid at depths of 7 to 15 ft. is not uncommon. As these larger and deeper drains were being constructed, the discovery was made that many of the tile previously laid were cracked, and in some cases had collapsed. As the depths were increased, the tile was called upon to support larger loads, which in some cases were too great. The tax-payers, tile manufacturers, contractors, and engineers then demanded an answer to two questions: How much load will a tile of a certain size and material carry? How much load is a tile required to support when laid at a certain depth in a certain soil? The old methods of judging tile by inspection and testing its strength by means of the long-handled 4-pound hammer are no longer satisfactory. Methods for determining the supporting strength of tile have been determined and have recently been incorporated in a set of standard specifications by the American Society for Testing Materials. The Iowa Engineering Experiment Station has published a bulletin giving the results of careful investigation of the loads which the trench-filling places on the tile, with an easy method of determining this load for each particular case.

As these two questions were answered, a third problem was presented for solution: that of manufacturing a tile of the required strength. The many cracked tile in the ground were evidence that the old methods were not producing tile which would meet the new requirements. Manufacturers and engineers set to work to find a tile which would meet their demands. The concrete-tile interests produced a tile with a greater thickness of wall. When this was found to be lacking, they tried reinforced concrete.

The first reinforced-concrete tile was supposedly strengthened by the addition of two or three hoops or rings of a single strand of heavy wire, placed in the centre of the tile-wall. Anyone who has seen such tile or who is familiar with concrete-tile manufacture realizes how seldom these rings were placed as intended.

Three things combined to make this reinforcement valueless for increasing the supporting strength of the tile, except after the tile-wall had been fractured. When a tile is loaded as in the trench the tile-wall at the four quarter-points, namely, the ends of the horizontal and vertical diameters, tends to revolve about the centre line of the wall, one face being in compression and the other in tension. No reasonable amount of reinforcement will increase the compressive strength of the concrete, and, placed as it was, this reinforcement could not take any tensile stress until after the tile-wall was fractured. As the strength of concrete is much greater in compression than in tension, the fractured wall of the loaded tile revolved about the outer edge of the compression-face, and as the crack on the tension-face widened, the reinforcement in the centre of the tile-wall received the load. If the reinforcement was placed at, or even near, the centre line of the tile-wall, it would act as an anchoring force and cause the segments of the fractured tile to act as an arch. The reinforcement did not prevent the tile from cracking, but it did, undoubtedly, prevent many cracked tile from collapsing. The bond between the concrete and any reinforcement which is effective must equal the stress tending to cause a movement of the concrete along the line of the reinforcement. The bond between concrete and a smooth galvanized-wire is not sufficient to take such a load, consequently when this tile was subjected to a heavy load, it cracked and the segment moved until such time as further movement required a lengthening of the hoops. This movement was due in part to the loose, twisted-loop connection of the two ends of the wire forming each ring. This connection was not rigid. Had the reinforcement been so placed as to

*Address delivered at the meeting of the American Concrete Pipe Association, Chicago, Illinois, February 1915.

†Drainage engineer, Iowa Experiment Station.

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take the tensile stress in the concrete, and had the bond between the concrete and the steel been sufficient to transmit this load to the reinforcement, it is probable that the wire hoop would have lengthened sufficiently at this connection to allow the concrete to crack before the wire could have taken the load.

During the winter of 1913-14 another step was taken in the production of a new type of reinforcement. This was composed of two concentric rings of No. 7 wire tied with 6 radial ties spaced 60 degrees apart. The ends of the wire forming each ring of the double hoop were electrically welded. The tie-wires were wrapped around each ring of the double hoop and the ends left projecting about ½ in. on the inside and outside to act as spacers. The specimens for this test were 28 in. 'tenth-wall' tile, made of a mixture of one part portland cement and 3 parts clean sharp gravel. The molded specimens were kept in the steam-room for five days and then rolled out into the yard for 20 days. After this they were moved into the warm engine room where they remained for 35 days until tested.

The tests were made in an Ames Senior testing machine, using sand bearings which distributed the load over a distance equal to 90 degrees measured on the circumference of the centre line of the tile-wall. The tests were made in accordance with the Iowa standard specifications which are very similar to those of the American Society for Testing Materials, except that the latter require that the specimens shall be tested wet. The loads at which the reinforced tile first cracked were recorded as the 'cracking' loads or the 'cracking' strength. The application of the load was then continued till the specimen failed, the maximum load being recorded as the 'breaking' load or strength.

As these tiles were all made the same day, on the same machine, of the same grade of materials mixed in the same proportions and were all given the same curing, it seems reasonable to use the strength of the unreinforced tile as a basis by which to judge the value of the reinforcing. The plain tile showed an average supporting strength of 2770 lb. per foot. In no case did the reinforced tile sustain as large a load as this before cracking, the average load per foot at which it cracked ranging from 2290 to 2670 lb. The specimens reinforced with two double hoops would support no greater load than that at which they cracked. In the other classes of reinforced pipe the ultimate breaking strength increased as the number of reinforcing hoops was increased, though the increase in strength was not proportional to the increase in the number of reinforcing hoops. The 3, 4, and 5-hoop tile had very nearly the same total strength per double reinforcing hoop, and sustained a larger load per double hoop than the 6-hoop tile.

The Collis Company of Clinton, Iowa, which had furnished the welded rings used in the Armstrong tests just mentioned, made up a number of concrete pipe-rings each reinforced with two hoops of reinforcing. These pipe-rings were 22-in. inside diameter, 6 in. long, and had a wall thickness equal to one-tenth of the inside diameter. They were made of a 1:3 mixture, hand tamped, and tested at the age of one month. The following classes of pipe-rings were tested: Class A, no reinforcing; Class B, reinforced with two double hoops with six radial ties. (This reinforcing will be referred to hereafter as the 'six-tie' type.) Class C, reinforced with two double hoops with twelve radial ties. Class D, reinforced with two double hoops with six radial ties and diagonal ties welded to each ring of the double hoop at six points. Class E, reinforced with two double hoops with six radial ties and diagonal ties welded to each ring of the double hoop at 24 points. (This reinforcement will be referred to hereafter as the 'bridge' type.) In all this work connections were electrically welded.

The concrete in these specimens was poor, which, with the fact that two double reinforcing hoops were used in a six inch section, makes it impossible to compare these results with tests of commercial reinforced concrete pipe. The tests were intended to show the relative value of these different types of reinforcing. They accomplished this purpose although they did not show the actual numerical relation, as in practically every case the strength of the concrete was insufficient to develop the strength of the reinforcement.

The unreinforced specimens had an average supporting strength of 328 lb. The 'cracking' strength of the reinforced specimens increased from 465 lb. for those of Class B, containing two hoops of the 'six-tie' type, to 1468 lb. for those of Class E, which had two hoops of the 'bridge' type. The increase in the strength added by the various types was greatest between the specimens of Class D and those of Class E. The breaking strengths, or the loads at which failure occurred, increased from 328 lb. for the unreinforced specimens to 1412 lb. for those reinforced with the 'six-tie' type, and to 1779 lb. for those reinforced with the 'bridge' type.

The results of these tests and those of January 1914 indicated that the strength of concrete pipe could be materially increased by the use of this 'bridge' type of reinforcement, and that it would increase the cracking strength as well as the ultimate strength. In order to secure data as to the value of the 'bridge' type of reinforcing when used in regular commercial work and to determine whether or not the use of a heavier wire for the bridging would be desirable, a number of test pipes were made by the Armstrong Cement Works and tested by the Iowa Engineering Experiment Station. The test specimens were manufactured and handled in the same way as the regular run of pipe from this factory and represent very fairly what can be expected of pipes of these kinds and ages.

Tests were made of plain 'tenth-wall' tile, 'tenth-wall' tile with two to six double hoops of the bridge type of reinforcing, and of 'twelfth-wall' tile with three hoops of this same reinforcement. In the 'tenth-wall' tile, tests were made of three classes of speci-

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mens, each containing three hoops of reinforcement, in which the diagonal bridging was of No. 10, No. 11, and No. 12 wire. The hoop wires in all this reinforcement were standard No. 7-gauge galvanized iron wire and the ties of No. 12 wire, except in the three classes just mentioned. The pipe was all 30 in. in diameter and 30 in. long. All of the reinforcement was made by the Collis company and donated for these tests. Connections were electrically welded; the diagonal bracing and the radial tire-wires being welded to the sides of the two concentric hoop-wires. The radial tie-wires were made to extend beyond the inner hoop so as to come within ⅛ in. of the inner casing of the mold and thus act as spacers. The test specimens were made of approximately one part portland cement and three parts sand to which had been added 10% of roofing gravel. The sand was clean and sharp, and had been screened through a No. 4 screen. Before using, this mixture of sand and gravel was again screened to remove large pebbles. The reinforcing hoops were spaced along the length of the tile by estimation, as is customary in the reinforced-pipe of this factory.

The pipe was taken from the machine directly to the steam-room. As soon as the room was filled, the steam was turned on and the pipe subjected to steam-curing for 24 hours. It was then rolled into a drying-room for a second 24 hours, after which it was rolled out into the storage yard, where it remained till tested. The pipe was made on September 24 and tested October 28 and 29. The tests were made on an Ames Senior testing machine using standard sand bearings. Records were kept of both the 'cracking' and 'breaking' loads of each pipe.

As might be expected, the first cracks appearing in the reinforced-pipe under tests were at the quarter points as in the unreinforced-pipe. The later appearance of circumferential cracks in the planes of the reinforcing-hoops was an indication that failure was imminent. These circumferential cracks most often followed the end-hoops, though such was not always the case. After being tested, each pipe was examined to determine the number and location of the breaks in the reinforcement. This examination gave rather inconsistent results in that with the pipe reinforced with three, five, and six hoops, breaks were found in the circular hoops, while the pipe reinforced with four hoops failed without the fracturing of any of these rings. In all cases the bridging, or bracing, was pulled loose from the hoops at both sides of each break. In many cases the weld between the rings and the bridging was found to be broken when the concrete had been broken away from the reinforcing. This, however, may have been caused by the pounding necessary to break up the concrete for examination after the test was completed.

The results of these tests do not show any consistent relationship between the failure of the reinforcement and either the 'cracking' or 'breaking' strength of the tile. Other things being equal, it would seem probable that the strongest specimen of a class would be the one in which the greatest strain was transmitted to the steel, or, that the strongest tile would be the one in which failure would be accompanied by the greatest number of breaks in the reinforcement. This assumption is neither upheld nor disproved by these tests, as in some cases it is borne out by the test data, while in other cases directly opposite results were obtained. Measurements taken after the test showed considerable variation in the spacing of the reinforcement in the different specimens of each class. This irregularity may account for the condition just mentioned, though it was not possible to establish any consistent relationship between the strength of the pipe and the uniformity of the spacing of the reinforcing hoops.

As in the other tests mentioned, the strength of the unreinforced-pipe will be used as a basis by which to judge the strength added by the various numbers of hoops of reinforcing. The unreinforced pipe had an average supporting strength of 1595 lb. per foot. The 'cracking' strengths of the reinforced pipe increased from 1755 lb. per ft. for the two-hoop pipe, to 2865 lb. per ft. for the six-hoop pipe. The increase was least between the two and three-hoop pipe and the greatest between the five and six-hoop specimens. These tests showed that the use of three hoops of this reinforcement would produce a pipe with nearly 30% more 'cracking' strength than unreinforced pipe; that the use of four hoops added 38%, and the use of six hoops nearly 80% to the 'cracking' strength of the plain pipe. The increase in the 'breaking' strength obtained by the use of this reinforcement was greater than that in the 'cracking' strength. The average 'breaking' strength of the two-hoop tile was 2440 lb. per foot. This increased with the number of hoops to 5160 lb. per foot for the six-hoop pipe, an increase of 223% over the breaking strength of the plain pipe.

The data from the tests which have been mentioned furnish conclusive proof of only one point, namely, that the strength of concrete tile can be increased by the use of these types of reinforcement. On the other hand, the data are insufficient to warrant any definite conclusions as to the increase of strength which may reasonably be expected to result from the use of a number of hoops of this reinforcement. So far, patented reinforcement only has been used in test specimens, so that there are no data as to type of reinforcement which will give the best results. The Iowa Engineering Experiment Station has planned a more extended series of tests which will be made during the coming summer and fall. The data from these tests should show pretty conclusively what can be expected of reinforced-pipe of the sizes tested, and it is hoped that they will indicate the requirements which the ideal type of reinforcement must meet. This work has gone far enough, however, to show that the present-day demand for stronger tile can be met with a properly made and reinforced-concrete tile.

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Municipal Tunnel and Highway at Richmond, California*

The city of Richmond is situated on San Francisco bay, eight miles northeast of San Francisco itself. Deep water exists close to shore and conditions are favorable for the development of an excellent harbor. A narrow ridge about 200 ft. high, however, separates the water-front from the filled-in marsh and nearly level plain that comprises the main part of the city. The Atchison, Topeka & Santa Fe railroad reaches its ferry terminal by means of a tunnel through this ridge. Beside the Santa Fe wharf, there are several others in the vicinity, but there has been no comprehensive plan of development. The city employed Haviland & Tibbetts of San Francisco to investigate the entire question considering both present and ultimate development. Their report, presented in September 1912, among other recommendations, advised the construction of a municipal wharf at the point shown in Fig. 1 and the construction of a highway and tunnel to render this wharf readily accessible from the main part of the city.

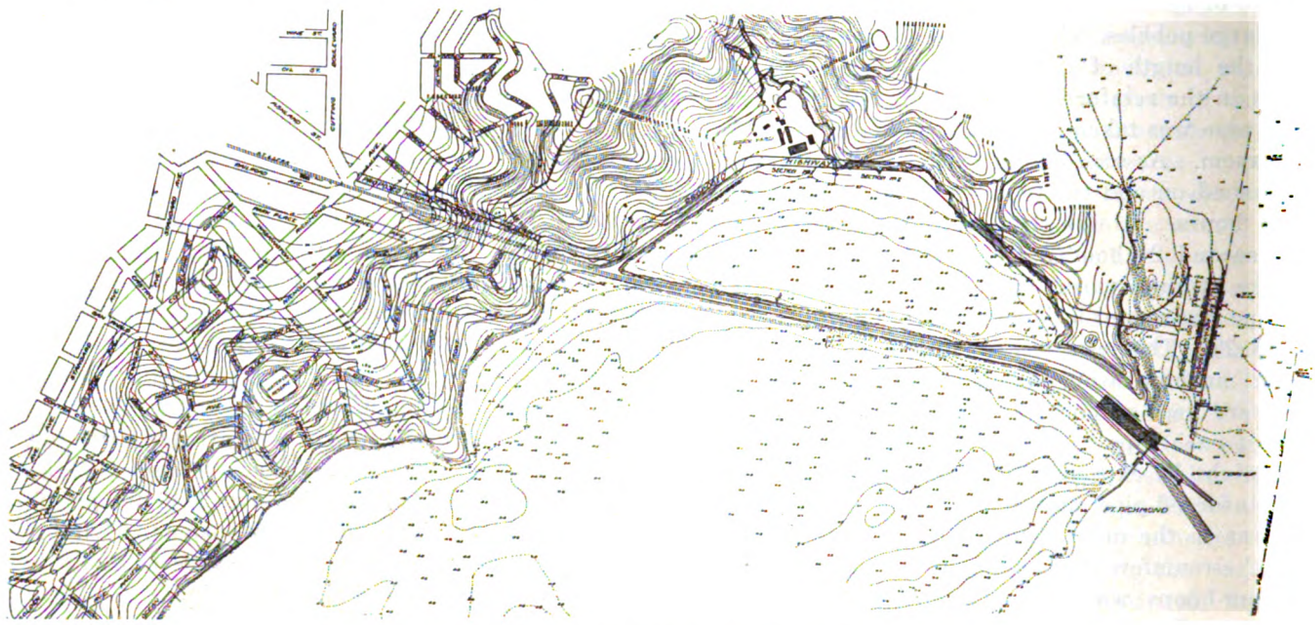

FIG. 1. MAP OF TUNNEL AND HIGHWAY.

The wharf is now under construction, the contract having been awarded to Healy-Tibbitts Construction Co. of San Francisco. The construction of the tunnel and highway was divided into two parts. The contract for the construction of 2000 lin. ft. of 60-ft. street at the wharf-end of the project was awarded to Moffett & Mead, of San Francisco. The contract for the construction of the tunnel and approaches and the remainder of the street work was awarded to Shattuck-Edinger Co. of San Francisco. Haviland & Tibbetts are the engineers for the entire harbor development.

The tunnel section and details are shown in Fig. 2. The excavation between the neat lines was 33.46 cu. yd. per lineal foot. The length of the tunnel is 732.2 ft. back to back of portals, or a total length, including portals, of 736.2 feet. A drift, 6 by 8 ft., was driven at each side of the tunnel and another at the top in the centre. Two 3¼-in. Ingersoll-Sargent piston-drills mounted on horizontal bars, were used at each drift. The gang in a drift was composed of two drillers, two helpers, and four shovelers, with one foreman for the top drift, and one foreman to take charge of both side-drifts. Nine 6-ft. holes were usually needed per round, and these were loaded with 40 lb. of 35% Hercules gelatin. The drift-timbers were 8 by 8 in. and were spaced from four to 6 ft. centres. The rock encountered was mainly quartzite and shale. After completing the drifts they were enlarged and connected to permit placing the arch timbering. An 11-segment arch composed of 12 by 14-in. timbers was used for most of the way. For a short time a five-segment arch was tried, but this seemed to give too much clear opening between the rock-wall and the timbering, and one bad slide resulted. The 11-segment arch was used for the remainder of the tunnel. The arches were spaced three-foot centres. The core was removed by a 2½-yd. Marion steam-shovel, working from the north portal, or the side nearest the main part of town. The excavated material was loaded into cars that were hauled into the tunnel by a one-ton electric locomotive and were run out by gravity. The material was hauled from the mouth of the tunnel by a 'dinkey' engine and used for filling in low land at various places near the north portal. For ventilation, an 18-in. blower mounted on a flat-car was used. During the driving of the

*From data furnished by H. I. Wood, resident engineer for Haviland & Tibbetts, Alaska Commercial Bdg., San Francisco.

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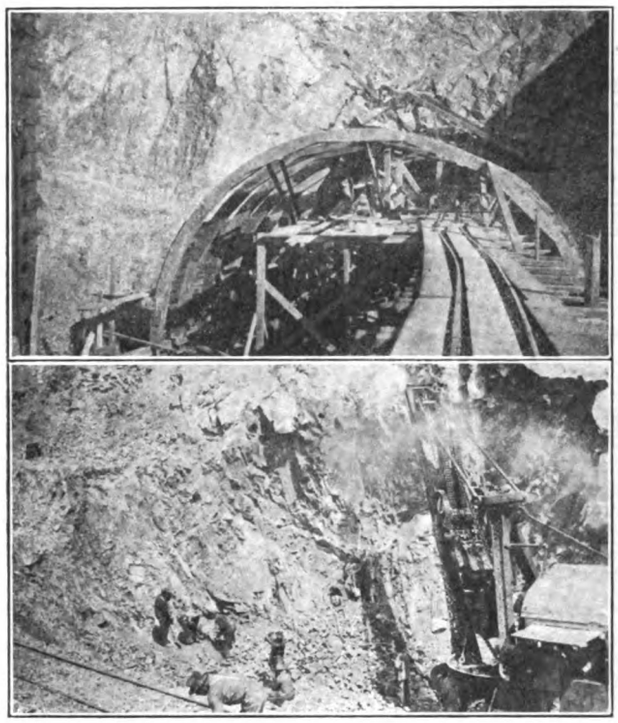
drifts, 'cross-cuts' were driven connecting the side-drifts at 150-ft. intervals, to assist in maintaining the proper supply of air. When the top drift reached the point for the south portal, a shaft was driven from the surface for the same purpose.

The concrete lining is shown in Fig. 2. The mini-



SOUTH PORTAL AT TWO STAGES OF WORK.

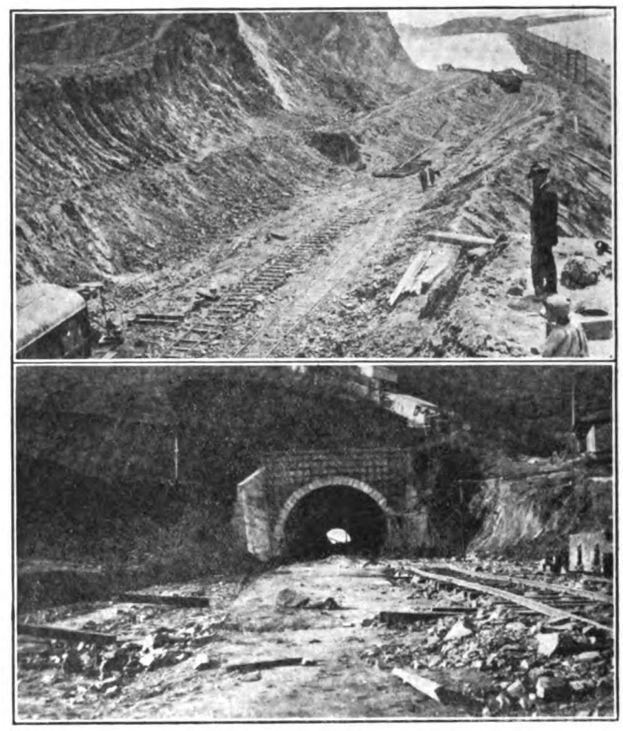
mum amount of concrete per lin. ft. was 7.7 cu. yd. Golden Gate cement was used. Sand was brought in barges from Rio Vista and delivered to bunkers near the work, as was also crushed rock from quarries of the Hutchinson Construction company. A 1:2:4 mixture of concrete was used. Mixing was done by a one-yard Ransome mixer. The concrete was transported to the forms by compressed air, the compressor being motor-driven and having a capacity of 875 cu. ft. of free air per minute. This capacity was not quite enough to get the best results from the mixer, it being found advisable to use ¾-yd. batches because the compressor was unable to handle the full output of the mixer. The concrete was deposited back of two-inch lagging, which rested on semi-circular forms made of I-beams. These could be used over and over again and were found much more satisfactory than wooden forms. The inside of the tunnel was given a smooth white finish, and is lighted by electricity, four-light clusters being spaced 26-ft. apart.

The portals are faced with Rocklin granite. The original ground surface at the south portal is steep. The portal has been placed a short distance in front of the actual mouth of the tunnel excavation, and the rock above the portal has been filled back on a 1½ to 1 slope until it meets the original ground surface.

As will be seen from Fig. 1, the tunnel is nearly parallel to the Santa Fe Railroad tunnel. From the north portal it is on a rising grade of 2½%, so that, on reaching the south portal, it connects with a street at right angles to the tunnel which crosses the Santa Fe tunnel just above its south portal. The street or 'highway' to the wharf is on light grades throughout.

The sidewalk on one side of the tunnel is elevated considerably above the roadbed, and an open space is provided under the sidewalk for pipes and wires. There is a railing between the sidewalk and the roadway. Provision has been made for a street-railroad through the tunnel, but no rails will be laid at present.

The approach to the north portal was excavated by a steam-shovel and the material used for filling adjacent land. The south approach and the remainder of the work on the Shattuck-Edinger contract was done with a steam-shovel. Most of this work was side-hill excavation, but there were some fills. The material over and above what was needed for the fills was used to widen the roadbed at different places.



HIGHWAY NEAR SOUTH PORTAL, AND VIEW THROUGH TUNNEL FROM NORTH PORTAL.

The heaviest part of the Moffett & Mead contract was a thorough cut about 400 ft. long near the end of the work. The maximum cut was about 50 ft. A steam-shovel was started at the top of this cut and a 'switchback' track laid to bring the material cars down to the grade of the highway. The steam-shovel gradually worked down to grade, taking out the material in several benches. Most of the excavated material from this cut was dumped into the water to build an embankment out to the wharf-site. The remainder of the work on this contract was light side-hill cuts and small fills.

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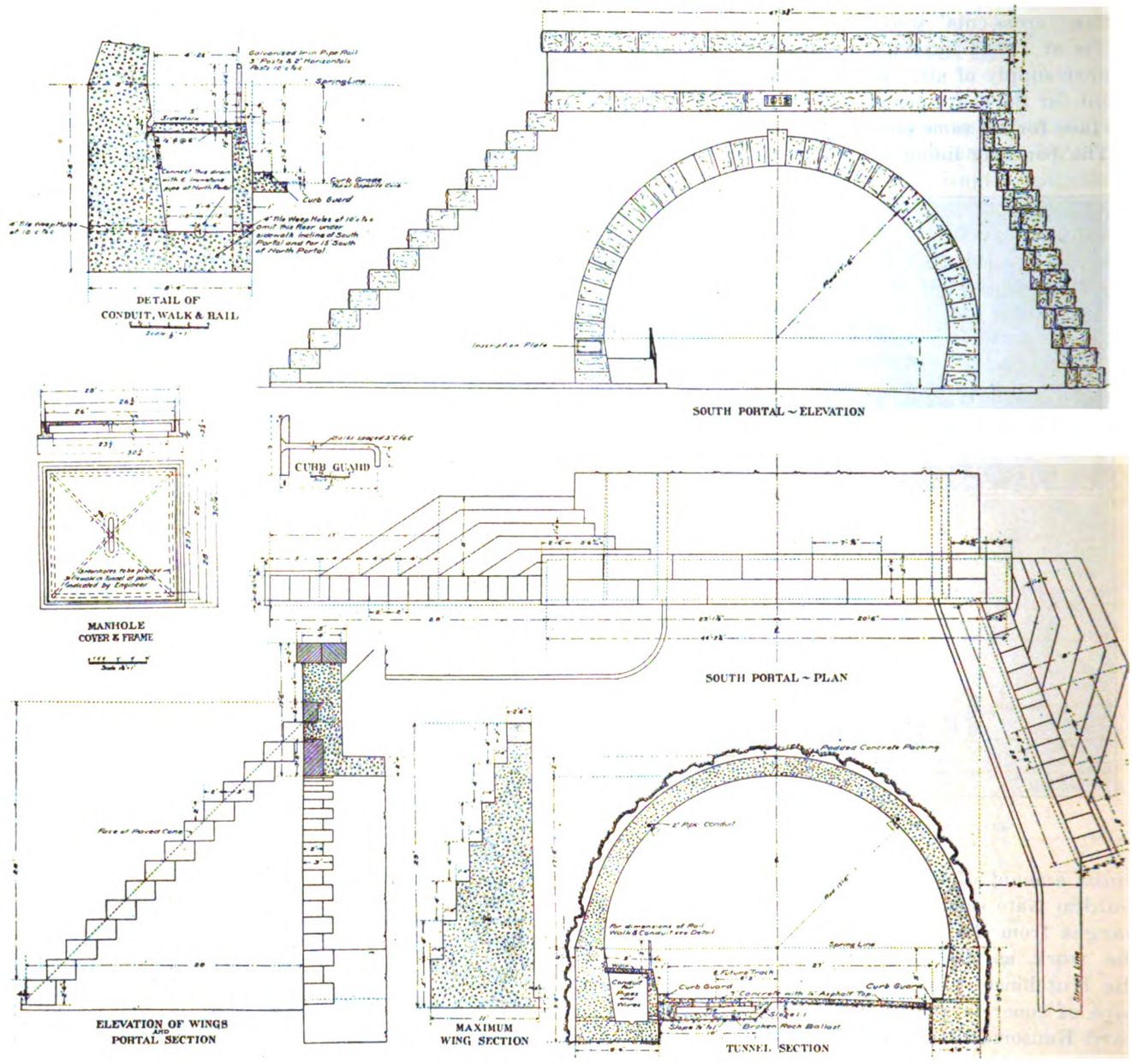

FIG. 2. DETAILS OF TUNNEL CONSTRUCTION.

Work on the tunnel commenced with the starting of the drifts on March 18, 1914, and they were completed as far as the south portal on May 29. Concreting was commenced about the middle of June and completed January 20, 1915. Most of the highway work was done between April and September of last year. The tunnel will be opened for use in June.

Following were the prices and approximate quantities for the Shattuck-Edinger contract.

24,500 cu. yd. tunnel excavation, at	$2.88
6,000 cu. yd. concrete in tunnel lining, at	8.85
1,300 cu. yd. concrete in tunnel portals, at	7.38
33,000 cu. yd. open-cut excavation, rock, at	0.52
25,000 cu. yd. open-cut excavation, earth, at	0.249

On the Moffett & Mead contract the prices were $0.56 per cubic yard for rock excavation and $0.23 for earth excavation.

A surge-tank on the differential principle has been constructed at the hydro-electric plant of the Salmon River Power Company, Altmar, New York. The structure is 180 ft. high to the top edge of the tank, which has a height of 80 ft. and a diameter of 50 ft., and stands on a base built up of ten lattice columns. The tank has to take care of surges from a column of water 9625 ft. long and 12 ft. in diameter. A 12-ft. riser connects the bowl-shaped bottom of the tank with the pipeline. Inside the tank is a 10-ft. vertical pipe tapered from 10 ft. 8 in. diameter at the bottom end to 15 ft. at the upper end. The annular space between the mouth of the 12-ft. riser and that of the 10 ft. 8-in. pipe allows part of the water to flow straight out into the tank, while the rest passes up the 10-ft. pipe. The effect is to throttle the surges very considerably.—*Mechanical World.*

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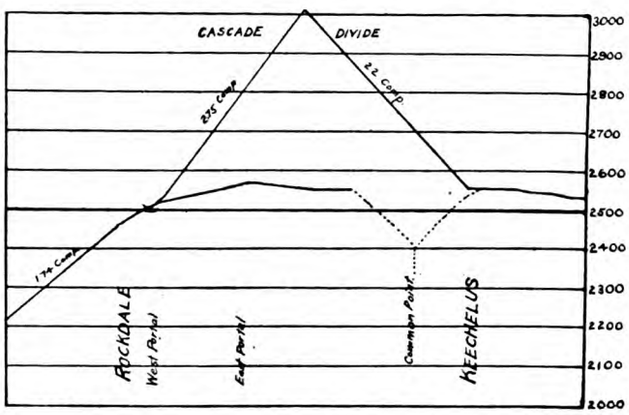
The Snoqualmie-Pass Tunnel*

The original line of the Chicago, Milwaukee & St. Paul railroad crosses the Cascade range at Laconia at an elevation of 3010 ft., requiring to reach this elevation 4.7 miles of 2.2% grade on the eastern side of the summit, and 4.4 miles of 2.75% grade on the western, with 1448 degrees of curvature in the entire distance over the summit. Mallet helper engines were necessary on all trains. In addition much trouble was experienced every winter from the heavy snowfall and in the winter of 1912-1913, traffic was entirely suspended for ten days on account of snowslides.

For these reasons the work of driving a tunnel under the main divide, as originally planned when the road was built, was commenced in June 1912, and the tunnel was completed and turned over to the operating department on January 24, 1915. The tunnel line leaves the line as originally constructed at Rockdale, which is 658 ft. west of the west portal, and connects with it again at Keechelus, about two miles east of the east portal. The tunnel itself is 11,902 ft. long, or about 2¼ miles. The total saving by the tunnel line is 3.7 miles of distance, 433.5 ft. of rise and fall, and 1239 degrees of curvature. Expressed in terms of dollars and cents, the annual saving is approximately as follows:



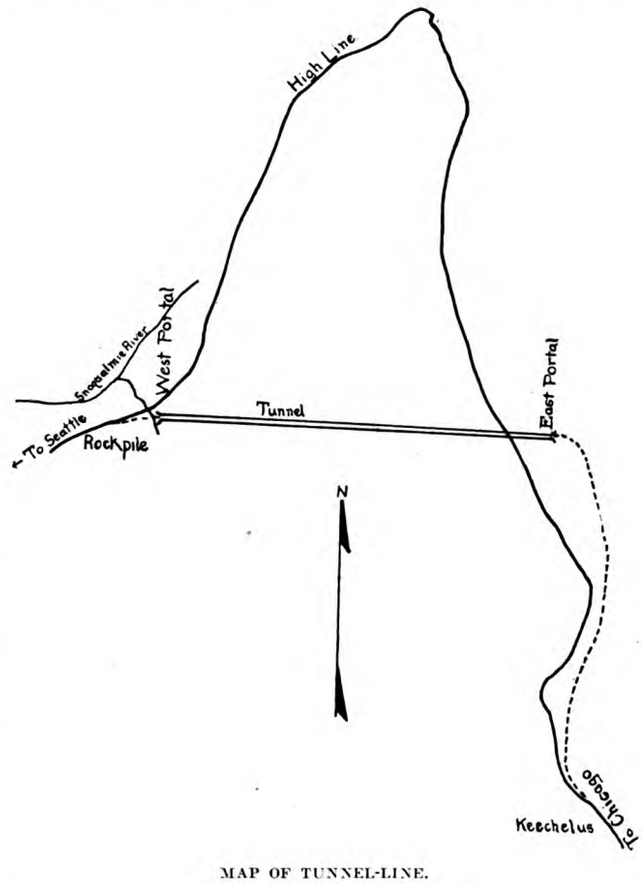
PROFILE OF OLD AND NEW LINES.

Helper engine service (now eliminated)	$ 90,000
Saving in distance and curvature (on basis of ten freight and six passenger trains per day)	21,600
Repairs and renewals of snowsheds, and interest on construction cost of same	36,300
	$147,900

The actual cost of the tunnel was about $2,000,000, so that the saving to be made indicates a return of 7½% on the investment without regard to the advantage of assured continuous operation of the line. Except for a short curve at each end, the tunnel is on tangent. From the east portal there is a 0.1% ascending grade, or just enough for drainage, for 2000 ft. and the remainder of the tunnel is on a 0.4% descending grade.

The tunnel is the first of any importance in the United States to be driven by the European or bottom heading method. An advance heading 13 ft. by 8 ft. high was driven at subgrade and at one side of the tunnel section. The heading was then brought to the full width of the tunnel section, after which stope-timbers were set with five-foot centres. These were bents composed of 12 by 12-in. posts and 12 by 14-in. caps with stringers running parallel to the tunnel, upon which was laid flooring that could be lifted to allow the 'muck' from the bench to fall into cars standing on tracks below the timbering.

After the stope timbers were set, shafts were driven upward about 150 ft. apart. From these openings the upper bench faces were drilled and shot down on the stoping-timbers and hauled away in cars. If the rock was in good condition, the stoping-timbers were taken down and moved ahead after the bench material had been removed. If it was soft or seamy, they were left in place and an 'A' frame constructed to hold the roof until the concreting reached that point.



MAP OF TUNNEL-LINE.

There was a long approach cut at the east end of the tunnel, which had not been finished when work at

*Staff article.

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the east portal was started. For this reason, a top-centre heading was used which was widened to full arch section and either timbered or concreted before the bench was taken out. Shafts were then sunk to subgrade at intervals of 1000 ft., from which drifts were run both ways and the rest of the bench removed by stoping as at the west end of the tunnel.

The heading gang was composed of a foreman, four drill runners, four helpers, ten shovelers, a helper, and a teamster. The usual division of time was about as follows: two and a half to three hours was spent after a blast in 'mucking out' sufficiently to allow setting up the drills again. To drill from fourteen to thirty 9-ft. holes, the number varying according to the character of the rock, took about seven hours. One hour was needed for moving the drills away, loading, and shooting, and one hour for waiting for the gases to clear from the heading. Under favorable conditions, therefore, the time between shots was about twelve hours, but various delays increased the average time to sixteen hours. Work was continuous, and the average progress in both headings was ten feet a day. For the bench the average was ten feet a day at the east end and eight feet on the west end. The tunnel section gives a clear width of 16 ft. and a height from the subgrade to the crown of the arch of 24 ft., or 22½ ft. from base of rail. Ninety-pound rails of American Railway Association section were used, with a 60-lb. guard rail for the entire length of the tunnel.

The rock encountered was mainly black slate with stretches of gray quartzite, blue conglomerate and an andesite dike, the latter being very hard. The rock itself was all of good quality, but had many seams filled with talc, necessitating a concrete lining for the entire tunnel.

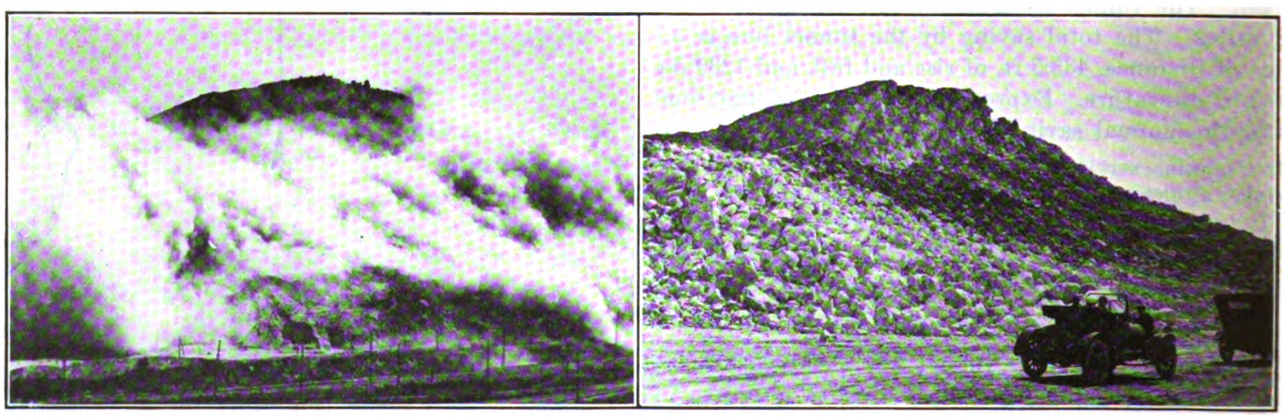
The concreting followed closely on the driving of the tunnel, in order to save timbering as much as possible. The gravel was obtained from a pit about 17 miles from the tunnel. At the pit it was sluiced directly into bottom-dump cars,which were hauled to the material yards at the tunnel portals, at which the concrete mixers were placed. The material yards were arranged so that most of the handling of materials was done by gravity with a minimum of labor.

To avoid interfering with the rock trains at subgrade, a track for the concrete cars was constructed at the springing line, 16 ft. above subgrade, by placing 8 by 12 in. timbers, 5 ft. centres with the ends projecting into the concrete sidewalls. Upon these timbers, the track for the concrete cars was laid. In this way, not only were the concrete cars kept out of the way of the rock cars, but it was possible to place about two-thirds of the concrete by dumping, and the concrete track supplied a support for the arch forms. The total amount of concrete placed was about 75,000 cubic yards.

The entire work was under the direction of J. I. Horrocks as engineer and superintendent of construction, with D. M. Allen as general foreman.

Large 'Coyote-Hole' Blast at Cement Quarry*

During the last five years, the manufacture of portland cement on the Pacific coast has grown to large proportions. To supply the raw material for this industry, many thousand tons of rock are quarried every year. The cost of blasting is an important item in any quarrying operations. In cement quarries, as the form in which the rock is broken is immaterial as long as it is small enough, it is possible to make use of the most economical methods of blasting. It has been found that when the rock to be broken is undermined by what is known as a 'coyote-hole' and a large charge of powder is used at one time the best results are obtained.



VIEWS OF BLAST AND ITS EFFECTS.

A large blast where this method was used was fired

*From data furnished by P. S. Taylor, Riverside Portland Cement Co., Riverside, California.

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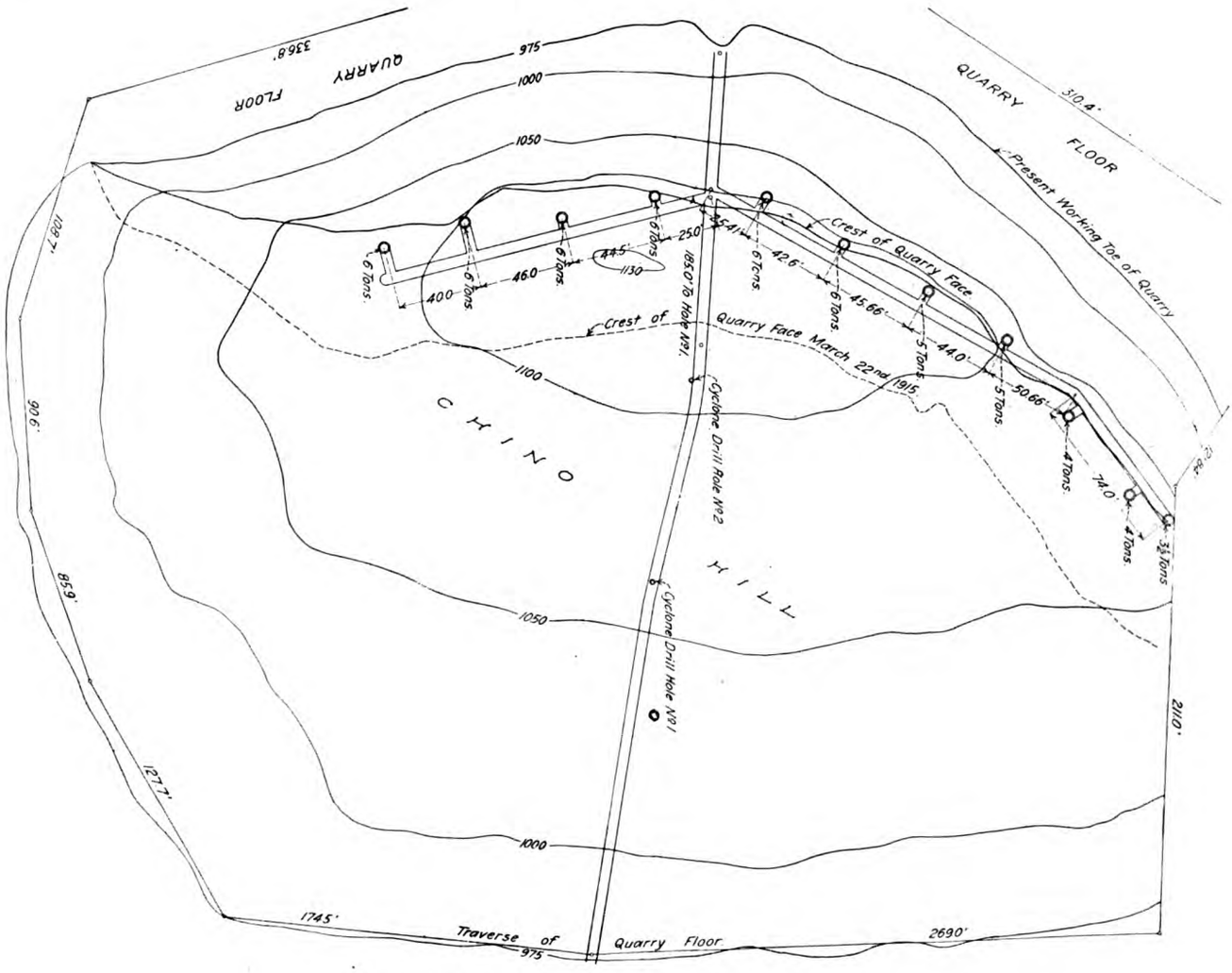

MAP OF QUARRY SHOWING POSITION OF POWDER CHARGES.

at the quarry of the Riverside Portland Cement Co., near Riverside, California, on March 23 last. As will be seen from the map, a tunnel was driven from the side opposite the working face of the quarry, allowing the regular operations at the quarry to proceed undisturbed while the tunnel was being driven. The tunnel was eventually driven clear through the hill. Side-galleries were driven from the tunnel and 11 powder charges ranging in size from 3½ to 6 tons were placed at the points shown on the map, making a total of 57½ tons. The powder used was 5% Hercules R.R.P. explosive. In addition, 1½ tons of 40% and 60% dynamite was used to fire the charge, as the R.R.P. explosive will not explode directly from a primer. Two No. 6 electric blasting caps connected in series were used in the primer for each charge.

The blast was fired with a No. 3 Hercules blasting machine. Before firing, all the circuits were tested with a galvanometer to make sure that there was no grounding of the current at any point. The blast was fired from a distance of 1000 ft. There was little noise and scarcely any vibration. Between 350,000 and 400,000 tons of rock was broken by the blast, or about 3½ tons of rock per pound of explosive used. Sufficient rock was broken to last several months.

The placing of explosive and firing the blast was done under the direction of A. H. Crane, of the Hercules Powder Co., San Francisco, California, who has superintended all large blasting operations for the Cement Company for the past two years. A remarkable feature of the blast was that he was able to predict where the new working face of the quarry would be, within a few feet, as well as the approximate amount of rock that would be loosened.

A growing practice is noted in iron-foundries to paint the patterns so as to indicate the parts of a casting which are to be machined and the parts which are to be left rough. The point is that castings are sometimes spoiled because the molder does not know what part is to be finished in the machine shop. The parts of a pattern corresponding to parts requiring no machine work are tinted grey, while the parts which are to be machined are painted yellow, with the parts of the pattern indicating the location of cores in red. Colored cards are sometimes employed for each pattern, for the use of the patternmaker and sometimes for the molder with the result that fewer castings have been ruined on account of their being gated wrong than was formerly the case.—*Mechanical World.*

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Industrial Progress

EXHIBIT OF BABCOCK & WILCOX CO. AT PANAMA-PACIFIC EXPOSITION

One of the most prominent features of the exhibit of Babcock & Wilcox Co., in the Palace of Machinery at the Panama-Pacific Exposition, is a boiler exhibited by the company in 1876 at the Centennial Exposition at Philadelphia. After the Exposition, the boiler was sold and remained in service until 1911, when it was re-purchased by the company. The boiler thus forms an interesting link between the two expositions, showing the progress in methods of construction of water-tube boilers during the intervening time. The Centennial boiler is essentially similar in design to those made by the company at present, but while the former had many parts of cast iron, the boilers now manufactured by the company are of wrought steel throughout.

Present practice in marine boilers is shown by a boiler made for the *Connecticut* of the United States Navy, and equipped with a superheater. There are three boilers to represent the land type, all with brick settings according to approved practice, half the setting being removed to allow an examination of the boiler. One of these is the well-known water-tube boiler with vertical headers. It is fitted with an oil-burning furnace. Boilers of this type now in use in different parts of the world are capable of generating 10,000,000 horse-power. Less common, but nevertheless, widely used, is the Stirling boiler, which consists essentially of three transverse steam and water drums set parallel. They are connected to a mud drum by three banks of water tubes so curved as to enter the drums radially. The boiler at the Exposition is fitted with a superheater and has an oil-burning furnace. The Rust boiler has also been found satisfactory under a variety of conditions. It is made of two transverse steam and water drums and two transverse mud drums connected by banks of tubes. The boiler shown as a part of the exhibit has a coal-burning furnace. The superheater made by the company is shown in connection with the boilers. It consists of two headers or manifolds, into which tubes bent to a U-shape are expanded. It is placed in the direct path of the products of combustion and the method of suspension, together with the flexible connections between the headers, is such that there can be no strains set up in the apparatus by contraction or expansion. The entire exhibit is well worth the study of those interested in the use of steam.

EXHIBIT OF HARRON, RICKARD & McCONE AT PANAMA-PACIFIC EXPOSITION

The largest single exhibit in the Palace of Machinery at the Panama-Pacific Exposition is that of Harron, Rickard & McCone. Of the forty companies for whom the firm acts as agent, twenty-six are represented in one way or another in the exhibit.

The Venn-Severin Co., of Chicago, has on exhibition a 60-hp. oil-engine which runs without either batteries or magneto. A few minutes before starting the engine, an ignition chamber is heated by a gasoline torch until it is hot enough to ignite the first charge. After the engine is running, the chamber is warm enough to ignite each charge. Another interesting feature of this engine lies in its being able to use with good results oil with as low a gravity as 25° Baumé and containing considerable asphaltum. The Sturtevant Mill Co., of Boston, is represented by several styles of rock crushers, rolls, and screens. While lack of space has compelled them to exhibit working models instead of the regular machines, the operation of the larger machines can be readily understood from an examination of the models.

The Joyce Cridland Co., of Dayton, is represented by a number of lifting jacks, both hydraulic and ratchet. The Aldrich Pump Co., of Allentown, Pennsylvania, exhibits a triplex pump geared to an electric motor. The American Hoist & Derrick Co., of St. Paul, has on exhibition two large hoists, one operated by steam and one by electricity, but otherwise identical.

Both well-drilling and well-pumping machinery are shown in the exhibit of the Keystone Driller Co., of Beaver Falls, Pennsylvania. There is a collection of drilling tools, a complete deep-well pump-head, and a model of a complete well-pumping plant, comprising a pump-head connected to an electric motor, the whole arranged so that it will pump water from a vessel in the same way as from a well.

The Koehring Machine Co., of Milwaukee, exhibits several concrete mixers. There are two of the ordinary type of batch-mixers, and to meet the demand for a machine that can perform a double function in the laying of bituminous pavements, there is a 'hot mixer.' This machine can be used like an ordinary concrete mixer in laying the base for a pavement, and then the drum heated and used to prepare the wearing surface. Such a mixer is also of great value as a portable repair plant for bituminous pavements.

The exhibit of the Sterling Wheelbarrow Co., of West Allis, Wisconsin, contains a number of wheelbarrows, concrete carts, and foundry flasks. The Grant Manufacturing Co., of Bridgeport, Connecticut, is represented by a riveting machine. The Beach Manufacturing Co., of Montrose, Pennsylvania, shows several saw tables.

An interesting feature of the exhibit of the Wyoming Shovel Works, of Wyoming, Pennsylvania, is a glass case containing two of the company's shovels that were used on Lieutenant Peary's successful expedition to the North Pole.

A number of concerns exhibit machine tools, among them being the Cincinnati Iron & Steel Co., of Cincinnati, which exhibits three lathes, the Aurora Tool Works, of Aurora, Illinois, which shows several drills, the Acme Machine Co., which has on exhibition a bolt-cutter, and a heading and forging machine, the Williams Tool Co., of Erie, Pennsylvania, which has pipe-threading machines of different sizes, the Oster Manufacturing Co., of Cleveland, which has a similar exhibit, the Smith & Mills Co., of Cincinnati, which shows two iron-shapers, the Stockbridge Machine Co., of Worcester, Massachusetts, which has a similar exhibit, the Landis Tool Co., of Waynesboro, Pennsylvania, which exhibits power grinding machinery, and the Builders Iron Foundry, of Providence, Rhode Island, which has a similar exhibit. Exhibits are also made by the United States Electrical Tool Co., of Cincinnati, which shows an assortment of portable drills and grinders, each one being mounted with the motor which drives it, and J. H. Andrews & Co., of New York and Sheffield, who have an exhibit of tool steel and of small machine tools.

Supporters of the 'safety-first' movement will be interested in the exhibit of goggles and other eye-protectors made by T. A. Willson & Co., of Reading, Pennsylvania. The Harrison Safety Boiler Works has an exhibit of feed-water metering heaters.

EDWARD R. BACON CO. EXHIBIT AT P. P. I. E.

In the exhibit of the Edward R. Bacon Co., of San Francisco, in the Palace of Machinery, at the Panama-Pacific Exposition, a number of the concerns for which the company is agent are represented. The C. J. Young Iron Works, Seattle, has on exhibition a drag scraper-bucket and a clam-shell dredger bucket. The Erie Machine Shops, Erie, Pennsylvania, is represented by a 5-ton tandem steam-roller. The Baker Manufacturing Co., Springfield, Illinois, has on exhibition a number of road-making machines, including a heavy wheeled scraper, a road-drag, and two road-graders.

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Several companies exhibit concrete machinery. The Jaeger Machine Co., Columbus, Ohio, has several small mixers of the well known 'Big-an-Litle' type. Van Duzen, Roys & Co., Columbus, Ohio, exhibits a mixer. The Foote Concrete Machinery Co., Nunda, New York, has a large traction mixer on exhibition. In the line of concrete-handling machinery, the J. C. Biegert Machine Works, Seattle, Washington, has a bucket and receiving hopper set up and attached to a single-friction drum-belt hoist.

Pawling & Harnishfeger Co. of Milwaukee, are represented by two large trenching machines. One of these has the buckets mounted on revolving wheel, which may be adjusted within certain limits for the depth of the trench. On the other machine, the buckets are fastened to an endless chain which revolves on a ladder frame, and may also be adjusted for depth of trench. Both machines are fitted with caterpillar traction so that they can be used on soft ground. They also exhibit a combination tamper, asphalt cutter, and concrete breaker mounted on a wagon and run by a small engine.

The Galion Iron Works, of Galion, Ohio, has on exhibition a road-drag, road-grader, and several road-scrapers. Another part of this exhibit that is of interest to highway engineers shows several sections of cast-iron culvert pipe and also corrugated iron culverts.

THE PETERSON OIL-FILTER

An oil-filter having great capacity in proportion to the space occupied is now being manufactured by the Richardson-Phenix Co., Milwaukee, Wisconsin. The oil is treated in three steps, as follows: first, heating; second, precipitation by allowing it to flow over a series of shallow trays; and third, the actual filtration. As will be seen from the accompanying illustrations, the oil passes through a strainer for removing the larger particles of foreign matter, and then to a heating tray.

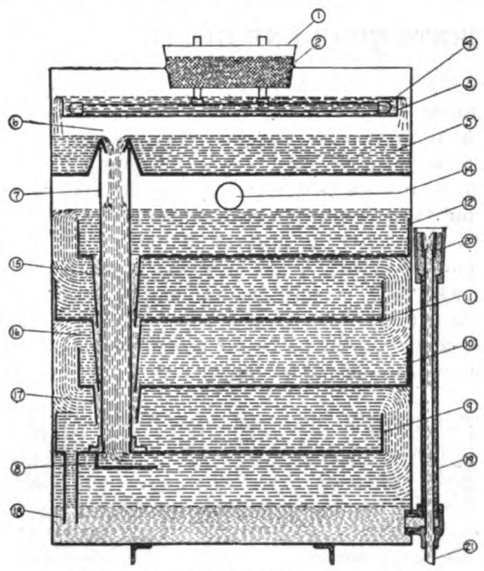

FIG. 1. CROSS-SECTION OF FILTER.

It then follows a circuitous route over a series of shallow trays, where a large part of the water and dirt is precipitated, the heating that the oil has undergone assisting this part of the process. The water collects at the bottom of each tray and is by-passed with funnels to the bottom of the oil chamber without coming in contact again with the oil itself. The water is removed by an overflow tube, so arranged that the column of water outside the filter is balanced by a column of water and oil inside the filter. As oil is lighter than water, this necessitates that the column inside the filter must be somewhat higher than that outside before water can flow out of the overflow tube.

From the settling trays, the oil passes into the filtering chamber. The filter-frames are designed to prevent folds in the filter-cloth, and the collection surfaces are vertical to assist

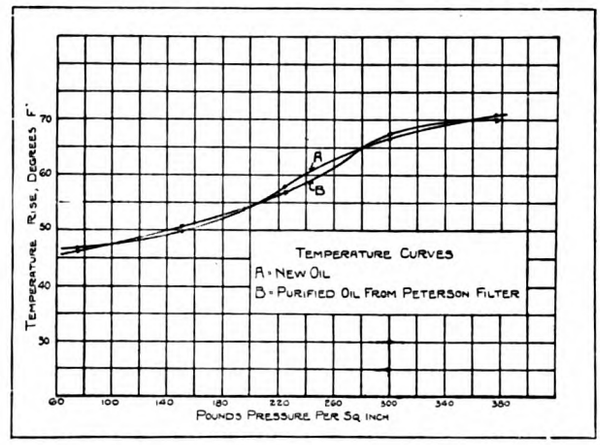

FIG. 2. RESULTS OF COMPARATIVE TESTS.

self-cleaning. The oil passes from the outside to the inside of the filtering units and is drawn by nozzles into the clean-oil compartment. Where necessary the oil is passed over cooling coils before being used again.

Comparative tests have been made with new oil and oil that had passed through a filter, the results being shown in Fig. 2, showing the excess of temperature in a bearing over the room temperature. It will be seen there is no appreciable difference in the lubricating value of the two oils. Oil may be used over and over again with this system, one plant where 1800 bbl. of oil circulates through the machinery a month being obliged to add only three barrels during that time. Theo F. Dredge, with offices in the Monadnock building, San Francisco, is district manager for the Richardson-Phenix Company.

THE COBB RAILROAD CROSSING

The type of crossing in general use at the intersection of two railroad tracks is open to serious objections. A great deal of wear on rolling stock results from the jar incident to the car-wheels passing over the rails of the intersecting track. Maintenance of the crossing and the adjacent roadbed also entails considerable expense. In cities, besides these financial considerations, there is much dissatisfaction with the usual type of crossing on account of noise. To meet these objections the Cobb Shockless Railroad Crossing Co., of Los Angeles, has devised a new type of crossing.

The essential feature of the design consists in so arranging the four or more rails forming the closing members of the intersection, as to give them vertical motion between fixed guides. The ends of these movable rails are framed at an angle with one another, thus forming an interlocking joint. They are given a vertical motion by the action of two wedges under each rail. These wedges move longitudinally as compared to the rail, and when in position to hold the rail in its uppermost position, they extend to the outer extremities of the rail. The rail is supported in the same way as a bridge is supported on piers. The wedges are also designed in such a way that when they are withdrawn, the rails are drawn downward. This arrangement, together with the solid guides provided to direct the vertical motion of the rail, insures that the rail will be under control in all its positions and locked solid when in position for use. The wedges under the several rails are so connected that when one pair of rails is raised to an operating position, the other pair is drawn downward to the lowest position. There are no moving parts in the whole construction except the wedges, which are subject

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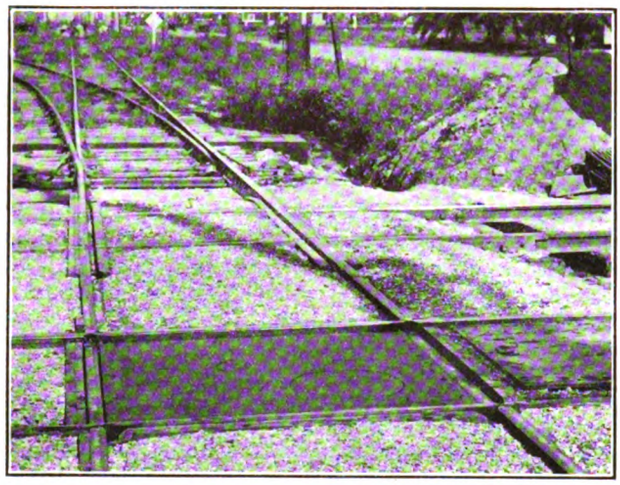
to any load due to traffic. These are of such form and proportions as to give long and safe service.

In the illustration, the smaller box shown between the rails, which is water-tight, contains the motor for operating the crossing. These crossings can also be operated by hand, chain, rod, switch throw, or compressed-air mechanism. The only requirement is that the main driving shaft running under the crossing shall make one-half of a revolution in one direction to bring one pair of rails into effective position, and then one-half of a revolution in the opposite direction, to bring the other pair of rails into effective position.

Two of these crossings have been placed at the intersection of the high-speed tracks of a four-track electric system and a single-track steam road. These are controlled from the same interlocking tower which controls the switches, derailers, and



VIEW OF CROSSING IN PLACE.

semaphores. Both crossings have been subjected, on the electric road, to a daily traffic of over 15,000 tons, and to 5000 tons on the steam road. The time required to make the change from operating position in one track to operating position in the other track is about 3½ seconds. During the six months time in which this intersection has been in operation there have been no delays in train service and no expense for repairs or maintenance.

The cost of placing one of these intersections is no greater than the cost of an ordinary intersection. When once set properly in place its main foundation parts need not be disturbed, and the rails or other wearing parts can be replaced without disturbing the tamping or adjacent paving materials.

EXHIBIT OF YUBA CONSTRUCTION COMPANY AT P. P. I. E.

The Yuba Construction Co. has installed at the Panama-Pacific Exposition two working models of Yuba No. 14, the world's largest dredge, one of them being in the Palace of Mines and the other in the California State building. These models are complete in every detail and can be handled from a switchboard just as Yuba No. 14 is handled from the winch-room, the bucket-line operated, spuds raised and lowered, dredge swung from side to side, and screen, pumps, and stacker started and stopped. Yuba No. 14 is equipped with buckets having a capacity of 16 cu. ft. and handles 10,000 cu. yd. of gravel and dirt per day, digging 70 ft. below water-level. The model is built on a scale of 1 to 20, with the exception of the buckets, which are on a scale of 1 to 12. The model would take five years to handle what Yuba No. 14 digs in one day, that is, 10,000 cu. yd. While the main drive motor of Yuba No. 14 is 400 hp., the model has a ⅛-hp. motor. Yuba No. 14 weighs nearly 2000 tons and the model weighs 1150 lb. Figures of men to scale placed on the deck of the model enable one to appreciate the comparative sizes of the regular dredge and of the model.

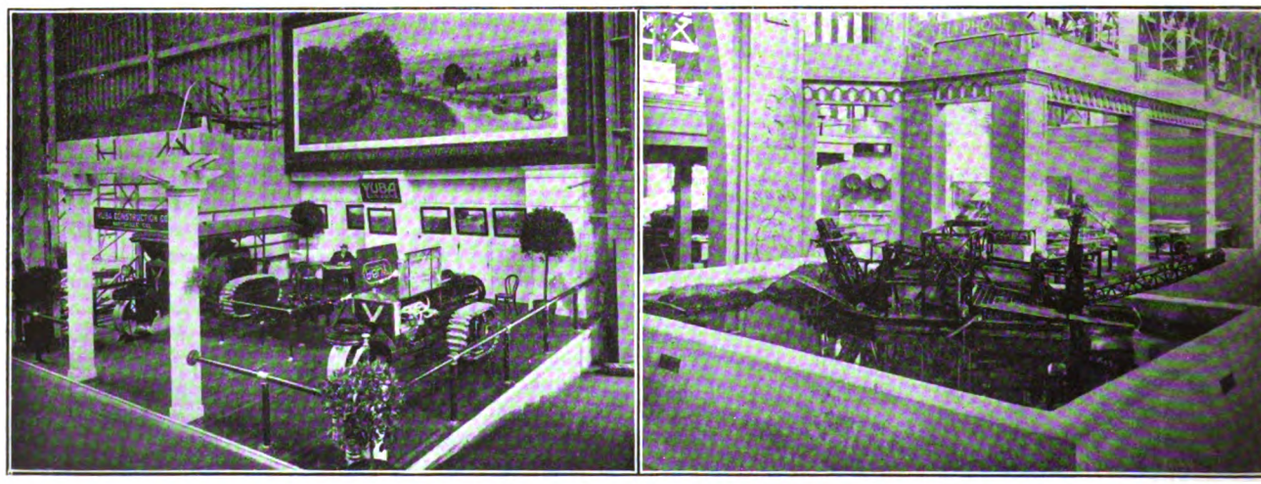
The company's exhibit of its ball-tread tractor in the Agricultural building is also interesting to engineers. Two tractors are on exhibition and the transmission is exhibited in operation. Two independent planetary clutches control the treads and one can be driven ahead while the other is being reversed. By the use of this mechanism it is possible for the tractor to be turned in its own length. The ball-bearing track is also exhibited. This track enables the tractor to be operated with minimum friction and suits it for side-hill work.

Hints on Practice

CONCRETE CURB AND GUTTER WITH PLAIN FINISH

In *Municipal Engineering*, E. B. Van de Greyn, describes an unusual form of combined concrete curb and gutter, which has given satisfaction in Denver, Colorado. The common practice in such work is to face the concrete body with mortar. The mortar face frequently checks badly and in some cases, the mortar falls from the body of the curb.

For some time past, it has been the practice in Denver to dispense with the mortar facing, and to make the finish directly on the concrete by spading and troweling. In such work the concrete should be so proportioned as to allow a surplus of mortar over what is needed to fill the voids.



TRACTOR AND DREDGE IN YUBA CONSTRUCTION COMPANY'S EXHIBIT.

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The most satisfactory mixture is 1:3:3, although a 1:2½:3½ and a 1:2:4 mixture have also been used. The concrete is mixed wet. After being placed, it is tamped if necessary, and a straight-edge resting on steel templets is worked back and forth to force down the stones and bring the mortar to the surface. A wooden or a steel float is used to finish the concrete. In constructing the curbs, the concrete is spaded thoroughly along the face-board, and the top of the curb is struck off with a straight-edge as with the gutter. After the concrete is dried a little the top of the curb is finished with a steel trowel. As soon as the concrete has set sufficiently, the face-board is removed and the side of the curb finished with trowels shaped especially for this work. When the finish has been made on both curb and gutter, they are covered and kept moist. Beside giving a more satisfactory finish, this curb and gutter is cheaper than the usual kind, contract prices in Denver ranging between 50 and 60c. per lineal foot.

As wages and cost of material in most Pacific Coast cities would be about the same as in Denver there would seem to be a considerable field for this class of construction.

CLEARING DITCHES WITH DYNAMITE

Trouble is frequently experienced in cleaning small irrigating ditches when, either from lack of time or from other causes, the work must be done when the ground is too wet to permit team-work. *Engineering News* gives an account of the way this difficulty was met by C. A. Edwards, of Gothenburg, Nebraska. Half-pound sticks of dynamite were placed 28 in. apart each way along the ditch, in two or three rows. When a good wind was blowing they were fired with a battery, about 20 sticks at a time. The holes were made with a one-inch gas-pipe, and were put down at an angle of 45 degrees with the vertical to the sandy bottom, usually about four feet. Where there was a good sand foundation and sufficient depth of water for tamping, the removal of the mud cost 18 to 20c. per cubic yard. Where there was no sand or water, the method was not successful, and it was necessary to excavate the material by hand. This would usually cost 50c. or more per cubic yard, or about three times as much as when dynamite could be used.

Engineers' Note Book

SOLUTION OF PROBLEMS BY THE USE OF THE 'LOG-LOG' SLIDE-RULE

The common slide-rule is in general use in engineering calculations, but comparatively few engineers are acquainted with the advantage of the 'log-log' slide-rule in the solution of many problems. Most of these rules have the following scales; the upper fixed scale is a 'log-log' scale; on the slide there is a scale corresponding to the regular 'C' scale of the Mannheim rule, a scale of tangents, and a 'C' scale inverted; the lower fixed scales are a 'D' Mannheim scale and one of equal parts.

The solution of a number of formulae by the use of the 'log-log' rule is illustrated below. In handling these formulae it is important to remember that the values on the 'log-log' scale are necessarily definite ones, and the corresponding values on the other scales must be chosen. This is not difficult, as the substitution of the tenth power or root of a quantity for the quantity itself is too great an error to pass inspection easily. As $e = 2.71828128$, which corresponds with the right and left indices, we have a series of values of

$$x = e^{n}, \text{ and } x = e^{\frac{1}{n}}$$

without resorting to the slide. To evaluate such expressions as

$$x = e^{an};\quad x = a^{\tan\theta};\quad x = \frac{\log_e n}{a};\quad \log_e x = \frac{n}{a};\quad \sqrt[a]{e} = n,$$

the slide must be set once, when a series of values of the dependent will appear for any chosen series of values of the independent variable. The solution of a number of formulae is illustrated below. Thus with formula No. 8, by placing 1 on the inverted 'C' scale over the value a on the 'D' scale, the value of x will be found on the inverted 'C' scale under the value of n on the 'log-log' scale.

These formulae require only one setting of the slide and involve only one face of the rule. The formulae given by no means exhaust the possibilities of the 'log-log' rule, but are enough to show its numerous uses.

Formula	1) $x = e^{n}$	2) $x = a^{\frac{1}{n}}$	3) $x = a^{n}$	4) $x = e^{\frac{1}{n}}$	5) $\log_e x = \frac{a}{n}$	6) $\log_b n = \frac{\log_e n}{\log_e b}$	7) $\log_e x = \frac{n}{a}$	8) $x = \frac{a}{\log_e n}$
Log-log	Read x	a x	a x	e x	x	b n	e a	n
C		1	1 n	1		1 $\log_b n$	x n	
T								
C 1				n	a n			1 x
D	Over n	n			1			a
L								

Formula	9) $x = n \log_e a$	10) $x = \frac{\log_e a}{n}$	11) $x = e^{\frac{a}{n}}$	12) $a^{x} = n$	13) $n^{x} = a$	14) $x = \tan\theta \log_e a$	15) $\tan\theta = \frac{n}{\log_e a}$	16) $\log_e x = a \tan\theta$
Log-log	a	a	x	a n	a n	a	a	x
C	1 n	1		1 x	1	1	1	
T						θ	θ	θ
C 1		n	1					1
D	x	x	a n		x	x	n	a
L								

Formula	17) $\theta = \tan^{-1}\frac{\log_e x}{\log_e n}$	18) $\theta = \tan^{-1}\frac{\log_e x}{a}$	19) $\theta = \tan^{-1} a \log_e x$	20) $\theta = \tan^{-1}\frac{n}{\log_e a}$
Log-log	a x	x	θ x	a
C	1		a	1
T	θ	θ	θ	θ
C 1		1		
D		a		n
L				

Formula	21) $x = a^{\frac{1}{\tan\theta}}$	22) $x = \frac{\log_e a}{\tan\theta}$	23) $a^{\tan\theta}\sqrt{e} = n$
Log-log	a x	a	e n
C 1	1	1	1
T	θ	θ	θ
C	θ tan	θ tan	θ tan
D		x	
L			

CHART SHOWING METHOD OF SOLVING DIFFERENT FORMULAE.

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Book Reviews

VALVES AND VALVE-GEARS. By Franklin DeRonde Furman. Vol. I, Steam Engines and Steam Turbines. P. 246. Ill., index. John Wiley & Sons, Inc., New York. For sale by *Mining and Scientific Press*, San Francisco. Price, $2.50.

The present volume is to be followed by another on valve-gears for gasoline, gas, and oil-engines. Together, they will form a complete text-book on the subject. Starting with the fundamental principles governing the admission of steam to the cylinder, the use of both the Zeuner and Bilgram diagrams is explained. Practical problems are given in the design of the various principal types of valve-gears. Eccentrics and shaft governors are also considered. The design of link-valves is discussed. The last chapter of the book is devoted to valves for steam turbines.

GOOD ROADS YEAR-BOOK FOR 1915. American Highway Association, Washington, D. C. P. 498. Price, $1.

A large amount of valuable information is contained in this book. The laws and systems of administration relating to highways in the various states of the Union are summarized, and considerable data on practice in foreign countries are also given. General specifications for the construction of the principal kinds of highways are given. There is a summary of road conditions in the United States and Canada. A bibliography is given, including the principal books on road-building as well as the various Government publications on the subject. Other parts of the book tell of college courses in road-building, a list of road associations, information regarding manufacturers of road material, and the constitution of the American Highway Association. One serious defect is the lack of a table of contents, the list which is called by that name being really an index.

DIRECT-ACTING STEAM PUMPS. By Frank F. Nickel. McGraw-Hill Book Co., Inc., New York. P. 254. Index. Illustrated. For sale by *Mining and Scientific Press*, San Francisco. Price, $3.

While the development of the centrifugal pump and its generally greater fuel economy has resulted in the displacement of the direct-acting pump in some cases, there remains, nevertheless, a large field of usefulness for the latter type of pump. The present volume, after tracing the historical development of the direct-acting pump, devotes a chapter to the consideration of the factors affecting performance and efficiency. The various types of pumps are then discussed. Pump-end details and steam-end details each have a chapter devoted to them. The selection of a particular type of pump to suit given service conditions is then discussed. Short chapters are devoted to the duty and to the operation and adjustment of direct-acting pumps. The appendix contains data on the friction head when pumping certain kinds of petroleum.

PRACTICAL OIL GEOLOGY. By Dorsey Hagar. P. 141. Ill., index. McGraw-Hill Book Co., Inc., New York. For sale by *Mining and Scientific Press*, San Francisco. Price, $2.

For many years the relations between the geologist and the 'practical' oil-man have resembled either armed neutrality or actual warfare. Like most other warfare, this has been caused by misunderstandings on both sides, while the extravagant claims of the extremists in both camps have tended to widen the breach. The present volume partakes more or less of the nature of an attempt by a geologist to extend the olive-branch to those on the opposing side. After discussing the theories of the origin of petroleum, its physical and chemical properties are briefly considered. The elementary facts of structurel geology and stratigraphy are considered and the value to the oil-man of a knowledge of these facts is clearly shown, both as regards the initiation of operations in 'wild-cat' territory and the placing of wells in both 'wild-cat' and proved fields. The book also treats briefly of some of the commoner problems in well-drilling and in maintaining production, and particularly the problem of combatting water. While there are occasional sweeping statements to be found in the book, which might mislead the novice, in general it will be found of value to those interested in the oil industry.

TUNNELING. By Eugene Lauchli. P. 230. Ill., index. McGraw-Hill Book Co., Inc., New York. For sale by *Mining and Scientific Press*, San Francisco. Price, $3.

In few branches of engineering has there been as much progress in the past few years as in tunneling. Improved kinds of machinery for drilling and for the removal of excavated materials have followed rapidly upon each other until records for speed in tunneling are broken almost as often as records for speed of automobiles. With improved machinery has also come more careful study of geological conditions with a view to predicting the formation, pressure, and temperature in long mountain tunnels, making possible the successful completion of tunnel projects that would have been doubtful at least a few years ago. The methods of driving tunnels of small cross-section and also of driving railroad tunnels of moderate length are discussed, but the driving of long tunnels is given the fullest treatment. The methods of removing excavated materials, and of ventilation in long tunnels are carefully considered. So also is the question of rock-pressure as affecting the lining of deeply-overlaid tunnels. Driving tunnels through soft materials by compressed air and by other methods is also considered.

ECONOMICS OF CONTRACTING. By Daniel J. Hauer. Vol. II. P. 334. Illustrated. E. H. Baumgartner, Rand-McNally Bdg., Chicago, Ill. For sale by *Mining and Scientific Press*, San Francisco. Price, $2.50.

The first volume of this useful work appeared two years ago. Volume II contains a large amount of new matter. It is probable that a larger proportion of contractors come to grief at one time or another of their business careers than of any other class of business men. A study of the present volume, written by a successful contractor, might prevent some of these failures. While the author lays considerable stress on the importance of cost records and estimating by analysis, other parts of the book are really more important, particularly because much has been written on cost-keeping during the past few years, while other equally important aspects of contracting have been almost neglected heretofore. One especially valuable chapter describes various methods for husbanding the contractor's funds until he can obtain payment for his work. Another chapter takes up the different classes of construction in turn and outlines a general plan for doing each job. Other parts of the book discuss handling men of all kinds from employees to public officials. Considerable space is also given to different phases of the law with respect to contracting. The book is badly in need of editing and condensation, two widely separated sub-heads in Chapter VI being 'The Liquor Evil' and 'The Drinking Evil,' but in general it will be found of great value.

CONCRETE HIGHWAYS. Association of American Portland Cement Manufacturers, Philadelphia, Pennsylvania. P. 114. Illustrated. Contains a list of the principal concrete roads which have been constructed in the United States, together with a summary of construction data for a number of these roads. There is also information regarding concrete foundations for other kinds of pavement. Specifications for concrete pavement are given.

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Construction News Summary

Condensed From Our Daily Construction News Service.

CALIFORNIA

AGNEW—Pacific Chemical Co. will erect $100,000 potash plant. Archibald Barnard, Merchants National Bank building, San Francisco, is interested.

ALAMEDA—Bonds for $300,000 for school purposes have been voted, and bonds for $200,000 for harbor work and $35,000 for playgrounds defeated.——Contract for construction of bitulithic pavement on Park street has been awarded to California Bitulithic Co., 4030 Hollis street, Oakland.——City council is considering a number of street extensions and improvements.

ANDERSON—Election has been called in Anderson-Cottonwood irrigation district for June 18, for purpose of voting on bond issue of $480,000 for construction of irrigation system.

ARBUCKLE—Citizens will pave 1645 ft. of street connecting with state highway.

ATASCADERO—Contract for concrete buildings costing $208,100 for Colony Holding Co. has been awarded to F. O. Engstrum Co., 5th and Seaton streets, Los Angeles.

AUBURN—Placer county board of supervisors has arranged to purchase $250,000 of state highway bonds, removing all obstacles to construction of highway from Roseville to Auburn. ——Contract for construction of Bear River bridge has been awarded to Jenkins & Wells, Sacramento, for $13,000.——Board of Supervisors is receiving bids for construction of two small concrete bridges over Coon creek on state highway. Estimated cost $6000.

BAKERSFIELD—Contract for work at city hall has been awarded to Weitzel & Larsen at 12½c. per sq. ft. for sidewalk and 16c. per lin. ft. for curbing.——Contract for construction of part of Glenville road has been awarded to F. H. Jameson for $6252.15.——Railroad Commission has authorized Bakersfield Water Co. to issue bonds for $25,000 for additions to plant and purchase of meters.——Contract for electrical fixtures for high school has been awarded to Kern Valley Electric Company.

BERKELEY—W. D. Henderson, Monadnock building, San Francisco, was low bidder for construction of school at Rose street and Shattuck avenue, at $32,270.——City engineer J. J. Jessup is preparing plans for asphalt pavement on concrete base on San Pablo avenue costing $140,000, and for storm sewers costing $20,000.

BLYTHE JUNCTION—Contract for construction of 41-mile railroad to Palo Verde valley has been awarded to Blythe Construction Co. G. W. Rice is chief engineer.

BRAWLEY—Contract for furnishing pipe for extensions to water system has been awarded to H. R. Boynton Co., 216 North Los Angeles street, Los Angeles, for $10,466.39. Contract for laying same has been awarded to Mesmer & Rice, Marsh-Strong building, Los Angeles, for $3552.——Contract for improvement of Main street has been awarded to California-Arizona Construction Co., Brockman building, Los Angeles.

BURLINGAME—Ten reinforced-concrete bridges will be built crossing ravines on various streets. Street paving on 38 blocks has been ordered. Eric Wold is city engineer.

CHICO—Contract for construction of model rural school at State Normal school has been awarded to C. E. Johnson, for $2873.——Pacific Gas & Electric Co. will build power-line to Paradise district.

COALINGA—Traders' Oil Co., Union Oil building, Los Angeles, will build a 55,000-bbl. steel tank on property.

CONCORD—Contract for paving 18 blocks of street has been awarded to Municipal Improvement Co., Richmond, for $20,789.

CROCKERS—Federal government will spend $15,000 on repairs to Tioga road.

CUTLER—Bowen & Davis, Fresno, are preparing plans for $8000 grammar-school building.

DUNSMUIR—Bonds for $25,000 for street improvements have been voted. Florence avenue will be paved with asphalt on concrete base.

EAST SAN DIEGO—Bonds for $70,000 for purchase and extension of water system were defeated.——Contract for improving Chamoune avenue has been awarded to C. L. Hyde Construction Co., 333 Spreckels building, San Diego, for $16,204.90. ——Contract for improving Swift avenue has been awarded to E. A. McAlpin, San Diego, for $14,343.77.

ESCONDIDO—Contract for erection of two pumping plants for municipal water system has been awarded to Western Gas Engine Co., 900 North Main street. Los Angeles, for $8958.

FRESNO—Contract for furnishing 125 carloads of brick, tile, and other clay products for construction of State Normal school buildings has been awarded to Los Angeles Pressed Brick Co., Frost building, Los Angeles.——City engineer B. E. Cronkhite is preparing plans for additions to sewer system to cost $500,000.——Ernest J. Kump is receiving bids for construction of school building, costing $7000, for Alta district.

FRUITVALE—City council is considering extending 12th avenue to waterfront.

GLENDALE—Contract for improving several streets has been awarded to E. Schiling, Burbank.

GRASS VALLEY—William Mooser, Nevada Bank building, San Francisco, is preparing plans for city library costing $15,000.

GRIDLEY—Contract for construction of grammar school has been awarded to Barton & Hite, Sacramento, for $9995.——Contract for construction of grammar school has been awarded to Barton & Hite.

HANFORD—Bonds for $672,500 for construction of 102 miles of county highways were voted.

HEALDSBURG—Citizens are considering building a road to Middletown. R. G. Cook is interested.——Contract for street paving has been awarded to City Street Improvement Co., 166 Geary street, San Francisco, for 18c. per sq. ft. Louis Lambretti, Mill Valley, has been awarded contract for curbs and gutters at 55c. and 15c. per foot respectively.

LINDSAY—Contract for paving 1750 lin. ft. on Sweetbriar avenue has been awarded to Worswick Street Paving Co., Fresno, at 15c. per sq. ft. for 5-in. concrete base, 1½ asphaltic surface and grading.

LONG BEACH—Contract for improving Fairmont boulevard has been awarded to Johnson-Shea Co. for $11,397.43.——Contract for improving East 7th street has been awarded to Star Cement Co., 217 Loring block, for $3054.83.——Contract for construction of steel lighthouse-tender 'Cedar' has been awarded to Craig Shipbuilding Co., for $250,000 ——Contract for improving several streets has been awarded to Fairchild-Gilmore-Wilton Co., Pacific Electric building, Los Angeles.——All bids for construction of addition to municipal wharf have been rejected and new ones will be received under amended specifications. B. F. Dupuy is city engineer.

LOS ANGELES—George R. Curtis, 552 South St. Louis street, has been awarded contract for improving 54th street, and for improving Yucca street for $3649.14 and $6899.60, respectively. ——Contract for improving 17th street has been awarded to O. L. Stevens, 1937 Darien place, for $715.21.——W. S. Garrett, 405 Currier building, is preparing plans for $40,000 concrete building for French Hospital Association.——Contract for construction of Micheltoreno Street school has been awarded to C. S. McCully, 2751 Francis street, for $23,000.——Contract for improving Manchester avenue has been awarded to O. L. Stevens, 1937 Darien place, for $1045.——Harbor commission is considering purchase of dredges for future harbor work instead of letting it by contract.——Fairchild-Gilmore-Wilton Co., Pacific Electric building, has been awarded contracts for improving Rampart street and for improving Clinton street for $4118.58 and $12,287.82 respectively.——Contract for improvement of Normandie avenue has been awarded to George R. Curtis, 552 South St. Louis street for $20,575.72. He has also been awarded contract for improvement of Wright street for $6558.18.—— Contract for improving Hoover street has been awarded to H. O. Withers, Builders Exchange, for $4360.64.——Coco Cola Co., 612 San Pedro street, will erect 4-story reinforced concrete building.——M. N. Yesberg, 1615 Morton avenue, has been awarded contracts for construction of Echo Park Avenue school and of 20th Street school at $17,500 and $41,860 respectively.—— Contract for construction of Western Avenue school has been awarded to Alex Grant, Builders Exchange, for $31,275.——Contract for construction of Hyde Park school has been awarded to Winget Construction Co., 413 Grant building, for $42,600.—— Contract for construction of 66th Street school has been awarded to Irvine & Dow, 618 American Bank building, for $35,483. ——Contract for construction of Staunton Avenue school has been awarded to C. S. Blodgett, 1953 Bonsallo street, for $39,138. ——Contract for construction of reinforced-concrete retaining-wall at Bimini Baths has been awarded to J. W. Cowan, 1072 Oxford street, for $20,000.——Contract for part of the grading and other improvements on property to E. T. Earl at Alta Canada has been awarded to H. V. Gentry, 335 South Bonnie Brae, for $12,071.47.——Contract for improvements in road district No. 91 has been awarded to R. H. McCray Co., 234 West 28th street, for $134,000.——Contract for furnishing 275 tons of crushed silica rock for roofing has been awarded to E. G. Judah Co. for 2472.25.——Following contracts have been awarded for roofing on Municipal Dock No. 1. For furnishing 1900 squares sheathing paper to E. J. Judah Co. for $1850; for furnishing 7600 squares of felt to George S. Turner, 2509 North 43rd street,

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Seattle, for $1888.60; for roofing cement to George S. Turner.——Contract for construction of Normandie Avenue school has been awarded to J. B. Dawson, 718 Fay building, for $23,720.——Contract for construction of 14th Street school has been awarded to John Harnish Co., 516 Stimson building, for $78,000.——Contract for road improvements in district No. 62 has been awarded to George S. Benson & Sons, Stimson building, for $14,887.——Contract for road improvements in district No. 82 has been awarded to R. H. McCray, 234 West 28th street, for $55,830.——Contract for improving 35th street has been awarded to A. Sikes, 1231 North Seward avenue, for $1339.35.——Contract for improving Fountain avenue has been awarded to California-Arizona Construction Co., 717 Brockman building, for $25,274.40.——Contract for improving Kohler street has been awarded to Ford & Stout, Bradbury building, for $11,031.01.——Contract for improving Meridian street has been awarded to A. C. Lowe, 500 Fay building, for $2561.09.——Contract for improving Dalton avenue has been awarded to Bryant & Austin, 1650 Compton avenue, for $11,257.86.——Rosedale Foundry & Machinery Co., Pittsburgh, Pennsylvania, was low bidder at $6240 f.o.b. factory, and $652 delivered, for furnishing two needle-valve outlets for Salt River project, Arizona.——California-Arizona Construction Co., Brockman building, was low bidder for bitulithic pavement on Santa Monica boulevard ——Council has decided to construct viaduct on 7th street over railroad tracks and river.

LOS BANOS—Odd fellows will erect $40,000 building. Ernest Kump, Fresno, is architect.

LOS GATOS—City engineer George Yocco has been authorized to purchase three corrugated iron culverts.

MARYSVILLE—Contract for construction of dredge for Marigold Dredging Co. has been awarded to Union Iron Works, San Francisco, for $400,000.——City council has decided to call election to vote on bond issue of $20,000 for sewer extensions and other improvements at Ellis lake.

McKITTRICK—Producers Transportation Co. will lay ten miles of 8-in. pipe-line in this vicinity.

MERCED—Contract for furnishing sewer pipe has been awarded to Gladding, McBean & Co., Crocker building, San Francisco, for $314.

MODESTO—Board of Trade is preparing petitions for bond election for system of county highway. T. H. Kewin is interested.——Contract for construction of fill across Indian Hill gulch has been awarded to Peart Bros., Oakdale, for $19,493.75.——Superior court has refused injunction against city's building bridge on Laurel street, for which W. H. Worswick was awarded contract at $1577.——Contract for paving alley between J and K streets has been awarded to W. H. Worswick, Jr., for 16c. per square foot ——Extensions and improvements will be made to municipal lighting system. W. O. Carpenter is city electrician.

MONTEREY—Bonds for $30,000 for street improvements and for $20,000 fire apparatus have been defeated.

MOUNTAIN VIEW—Howard & Ellis, Redwood City, are low bidders for paving Castro and Front streets.

NEVADA CITY—James Hawks will commence dredging operations on Deer creek.

OAKLAND—Contract for improving 29th avenue has been awarded to Hutchinson Co., 13th and Franklin streets. Contract for improving Walsworth avenue has been awarded to Oakland Paving Co., First Trust & Savings building. Contract for sewers on Bedford street has been awarded to J. Catucci, 1230 18th street. All bids for improvement of 12th street have been rejected.——Hutchinson Co., 13th and Franklin streets, has been awarded contract for improvement of Vine street and of 83rd avenue.——Contract for improvement of High street has been awarded to A. H. Kopperud, 4217 Foothill boulevard.——Bids will be received until noon, June 3, by Frank M. Smith, city clerk, for grading, redwood curbs, concrete gutters, and oil macadam pavement on 23rd street. Bids will also be received until the same time for grading, concrete curbs and gutters, cement sidewalks, oil macadam pavement, corrugated iron culverts, and 8-in. sewer on 72nd avenue. Perry F. Brown is city engineer.——Board of supervisors will receive bids until June 14 for construction of concrete foundations for county infirmary. C. P. Weeks, Mutual Bank building, San Francisco, is architect.

OROVILLE—Because of protests from property-owners, board of trustees has rescinded resolution ordering improvements on certain streets, and has annulled contracts recently awarded to Hammon Engineering Co. for these improvements.

PALO ALTO—Contract for water-main extensions has been awarded to James Stanley, Sausalito, for $13,396.——Contract for several blocks of street pavement has been awarded to Federal Construction Co., San Francisco, for 10½c. per square foot.

PASADENA—Contract for improving Arroyo drive has been awarded to Andrew Holloway, 471 South Broadway, for $26,159.45.

PLACERVILLE—Marigold Mining Co., Marysville, has purchased quartz claims owned by Hines Gilbert G. M. Co. and will develop same.——Lewis A. Stockley, Lick building, San Francisco, and W. L. Clark have purchased group of mines on French creek, and will spend $1,000,000 on development, including the purchase of machinery.——Contract for construction of warehouse for Fruit Growers' Association has been awarded to U. C. Meyers, for $1164.

PORTERSVILLE—City council has passed resolution of intention for paving several streets with 5-in. concrete base and 1½-in. asphaltic wearing surface.——City council is considering bond issue for improving streets around high school grounds and for widening Main street bridge.

PUENTE—Contract for construction of high school has been awarded to Widdle & Herington, 405 Currier building., Los Angeles, for $44,861.

REDONDO BEACH—Contract for construction of high school has been awarded to Los Angeles Planing Mill Co., 1800 Industrial street, for $102,760.——Citizens are considering harbor improvements to cost $1,500,000. F. R. Rancher is interested.

RICHMOND—Contract for improvement of 16th street from Ohio to Potrero has been awarded to G. M. Fisher for $18,022.08.——Council has adopted plans for bitulithic paving on 10th street. H. D. Chapman is city engineer.

RIVERSIDE—Contract for construction of concrete drainage conduit on Fairmount boulevard and on Market street has been awarded to Mlagenovich & Gillespie, 3920 Wisconsin street, Los Angeles, for $28,381.10.——All bids for furnishing 7000 bbl. class A road oil and 12,000 bbl. class B road oil have been rejected and new bids will be received under different specifications.

ROSEVILLE—Bonds for $10,000 for additions to school buildings have been voted.

SACRAMENTO—Contract for construction of water system has been awarded to Schaw-Batcher Co., Sacramento and 356 Market street, San Francisco, for $593,528.59. Freight on pipe, which is to be paid by the city, will cost $123,000, making a total of $716,528.59.——J. R. Coughlan, receiver for the Northern Electric railroad, has reported that the cost of repairing damages to bridge at Meridian will be $46,980. Colusa county, Sutter county, and the railroad will share the expense.——Following contracts for state highway work have been awarded: In Sonoma county from Willow Brook to southern boundary, 6½ miles, to Twohy Bros. Co., First National Bank building, San Francisco, for $39,729; in Contra Costa county, from Richmond to Pinole, 5½ miles, to Bates, Borland & Ayer, Oakland Bank of Savings building, Oakland, for $28,082 50; in Monterey county, from Lagunita to Salinas, 6 miles, to T. M. Burns, Sacramento, for $30,662; in Monterey county, from Bradley to San Ardo, 11 miles, to Frank L. Smith Co., Eureka, for $92,435.20. Contract for work in Monterey county near Kings City is still under advisement.——Governor Johnson has signed bills appropriating $250,000 for improving navigation conditions on the Sacramento, San Joaquin, and Feather rivers, creating large reclamation districts along west side of Sacramento river, creating Knight's Landing Ridge drainage district, and validating organization of district No. 108.——Contract for paving approaches to 12th street bridge over American river has been awarded to Clark & Henery Construction Co., for 13.9c. per square foot.——Contract for construction of buildings at State Hospital at Norwalk has been awarded to E. L. Bergen & Son, San Francisco, for $114,872.——Contract for improvement of 12th street has been awarded to Hughes Construction Co. Contract for improvement of D street has been awarded to McGillivray Construction Co.——Contract for construction of reinforced-concrete sewer on 31st street has been awarded to James Kennedy Construction Co., Washington building, Los Angeles, for $81,052.48. Clinton Fireproofing Co., of San Francisco, bid $81,013 41, but its bid was declared irregular.——Legislature has decided to increase the proposed additional state highway bond issue from $12,000,000 to $15,000,000.——Contract for improvement of E street has been awarded to O. Larsen.——Contract for improvement of 17th street has been awarded to Clark & Henery Construction Co.——James Kennedy, Washington building, Los Angeles, has been awarded contract for construction of unit No. 5 of trunk-line sewer for $104,000.——Contract for improvement of E street has been awarded to McGillivray Construction Co., San Francisco.——Contract for improvement of Third street has been awarded to C. E. Hodson.

SALINAS—City council is receiving bids for paving Alisal street with oil macadam, including concrete gutters. Estimated cost, $25,000.

SAN BERNARDINO—Contract for construction of 3½ miles of concrete highway on Archibald avenue has been awarded to L. Fleming & Son, 105 North Park avenue, for $16,004.24.

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SAN DIEGO—Contract for paving Broadway has been awarded to Fairchild-Gilmore-Wilton Co., Pacific Electric building, Los Angeles, for 24c. per sq. ft. for asphalt paving, and 38c. per lin. ft. for curbing.——Contract for 5 miles of grading on San Diego & Arizona railway has been awarded to Robert Sherer & Co., Pacific Electric building, Los Angeles.——C. C. Tucker has been awarded contract for construction of race-track at Tia Juana.——J. R. Comly, assistant city engineer, is preparing plans for concrete drainage conduits one mile long and four to five feet in diameter.

SAN FERNANDO—Contract for construction of two buildings for high school has been awarded to John Mulder, 143 South Rose street, Los Angeles, for $51,891. Contract for construction of a third building has been awarded to George C. Condon, 424 Wesley Roberts building, for $42,800.

SAN FRANCISCO—Board of Public Works is receiving bids for construction of two class A buildings for fire-houses and a class A building for juvenile detention home.——Following street work has been ordered: sidewalks, curbing, brick catch-basins, and brick and asphalt pavement on 12th avenue; sewers and asphalt pavement on 44th avenue; grading, curbs, sidewalks, sewers, and asphalt pavement on part of 44th avenue; redwood curbs, sidewalks, and broken-rock pavement on Kirkham street; sewers, concrete curbs, and asphalt pavement on Moraga street; redwood curbs, sidewalks, and broken-rock pavement on 21st avenue; sewers on Lessing street.——Contract for building $1,000,000 oil tanker for Union Oil Co. has been awarded to Union Iron Works.——State Board of Harbor Commissioners has approved plans for reinforced-concrete viaduct across Embarcadero at foot of Market street. Board has also approved plans for extension of pier No. 20 and for upper-deck landings at new ferry-slips. Contract for rolling doors at pier No. 24 has been awarded to C. Jorgensen & Co., 356 Market street.——Board of Public Works has ordered the following improvements: paving on Fulton street; grading and sewers on Vermont street, costing $11,500; paving on Balboa street, costing $5100; grading and paving on Geary street, costing $4600. ——Contract for construction of sewer on 28th street has been awarded to C. B. Eaton, 11th and Harrison streets, for $7731. ——Bids will be received until 10 a.m., June 9, by L. H. Rand, U. S. Army Engineer Office, 405 Custom House, for furnishing fuel oil and engine distillate for dredges. Detailed specifications on file at office of 'Western Engineering.'——Following street work has been ordered: curbs, and basalt and asphalt pavement on College avenue; curbs and asphalt pavement on San Bruno avenue; grading on Olmstead street; and sewers on De Haro street: asphalt pavement on Boyce street; curbs and basalt and asphalt pavement on 18th avenue; sidewalks on several streets.——Leon M. Hall, Kohl building, is preparing plans for hydro-electric plant on south fork of Humboldt river, Nevada, to develop 1500 horse-power.——The following street work has been ordered: Sidewalks on Howard, Shotwell, 7th, and 22nd streets. Concrete curbs and basalt and asphalt pavement on Cumberland street.——Contract for construction of addition to Fine Arts building at Exposition awarded to David Graham, 693 Mission street, for $20,000.——Following contracts for street improvements approved: sewer in Meda avenue, to C. S. Allred, 150 Onondaga street; improvement of Shotwell street, to E. J. Mize, 96 Bernal avenue; improvement of St. Rose's avenue, to City Street Improvement Co., 166 Geary street; paving Mendell street, to Flinn & Treacy, First National Bank building.——Following street work has been ordered: sewers, concrete curbs, catch-basins, culverts, and asphalt pavement on 43rd avenue; concrete curbs, vitrified brick and asphalt pavement, catch-basins, and culverts on Wisconsin street.

SANGER—Contract for construction of Carnegie library has been awarded to W. H. Jones for $8963.

SAN JOSE—Contract for improvement of William street has been awarded to W. J. Jessup for 14c. per sq. ft. for asphalt pavement on 4½-in. concrete base, 30c. per lin. ft. for curbing, 14c. per sq. ft. for gutters, 50c. per lin. ft. for 8-in. vitrified pipe drains, and $32.50 each for catch-basins.——Contract for graveling Hull avenue has been awarded to Montoya & Winklebach.——Contract for paving three blocks on 11th street, three on 8th street, and six on John street, awarded to Raisch Imp. Co., Crocker building, San Francisco, at 13½c. per sq. ft. for 4½-in. asphaltic concrete base and 1½-in. asphaltic wearing surface.——Contract for same kind of pavement on seven blocks on San Antonio street has been awarded to Clark & Henery Construction Co, Sacramento, for 13½c. per sq. ft.——Contract for paving three blocks on 12th street with 4-in. base and 1½-in. wearing surface has been awarded to F. R. Ritchie & Co., Chronicle building, San Francisco, for 13c. per sq. ft.——Contract for construction of reinforced concrete bridge over Los Gatos creek has been awarded to J. W. Williams for $52.80.—— Board of supervisors will receive bids until 11 a.m., June 7, for repair of 5½ miles of Alviso road. H. A. Pfister is county clerk. ——Contract for construction of sewers on several streets has been awarded to Casley & Henwood for $1575.——Contract for improving East San Carlos and East San Salvador streets has been awarded to Teichert & Son, Sacramento, for 13.7c. per sq. ft. for grading, 4½-in. concrete base and 1½-in. asphalt wearing surface, 37c. per lin. ft. for curbs, 16c. per sq. ft. for gutters, 60c. per lin. ft. for drain pipes, and $35 each for catch-basins.——Bids will be received until 11 a.m., June 7, by H. A. Pfister, county clerk, for furnishing 50,000 bbl. cement during the next two years, delivery to be made at various parts of the county.

SANTA BARBARA—McDermott Undertaking Co. will erect $10,000 reinforced-concrete building.

SANTA MONICA—Contract for improvement of Garfield avenue has been awarded to Joy Construction Co., Sawtelle.

SANTA ROSA—Contract for construction of concrete bridge at Melitta has been awarded to Call Construction Co. for $3744 for bridge, 25c. per cu. yd. for backfill, and $1.50 per cu. yd. for gravel.——Board of supervisors will receive bids until noon, June 7, for construction of steel bridge over Lambert creek. M. P. Youker is county surveyor.——Clark & Henery, Sacramento, were the only bidders at 16.4c. per sq. ft. for paving Santa Rosa avenue. Bid taken under advisement by council.

SEBASTOPOL—Contract for construction of school building has been awarded to Ernest Parfitt for $14,000.

SELMA—City will construct 12-in. sewer one-half mile long.

SIERRA MADRE—Contract for drilling well for municipal water system has been awarded to Clampitt & Moss, 959 East 4th street, Los Angeles, for $2596.47.

SONOMA—Contract for street paving has been awarded to City Street Improvement Co., 166 Geary street, San Francisco, for 18c. per square foot.

STOCKTON—Contract for construction of 138 ft. of concrete bulkhead on Stockton channel has been awarded to Jacobs & Sayles for $36.23 per lin. ft.——W. G. Hunter has reported on proposed irrigation system near Tracy. System will cover 12,000 acres and cost $285,000. Plans include 2400 ft. of intake canal at Bethany, wood-stave pipe to higher lands, two pumping plants, each for 50-ft. lift, and two main distributing canals. ——Board of supervisors will receive bids until 10 a.m., June 8, for furnishing and operating a dredge to construct I. L. Borden road from Old river to Middle river, 4¼ miles.——Charles Young is preparing plans for $25,000 armory, provided for by recent state appropriation.——City council has adopted plans for paving thoroughfare along waterfront with asphalt macadam.——Election will be held June 15 to vote on bond issue of $550,000, $350,000 for sanitary sewers and $200,000 for storm sewers. C. E. Compton is city engineer.——City council has authorized placing of a number of street-lights.——Contract for street work in Yosemite Terrace district, which was awarded to Teichert & Sons, Sacramento, has been transferred to R. C. Tumelty, the price, $27,000, remaining the same.—— Bids will be received until June 8 by board of supervisors for construction of bridges on Borden road across Middle river and Old river. Estimated cost, $70,000.——Bids will be received at the same time for improvement of 1190 lin. ft. of Yosemite avenue in Manteca.——County surveyor F. E. Quail is preparing plans for oil macadam on West's lane and for graveling two miles of Brookside road.——Contract for improving C. A. Howard road with water-bound macadam a distance of 12 miles has been awarded to Cy. Moreing & Sons for $65,000.——City council is considering paving about 50 blocks of streets with asphalt macadam.——Contract for construction of sanitary sewers in Gambetta addition has been awarded to Bishop & Tumelty for $7285.44.——City council has decided to have eight electrollers on Sutter Street bridge.

TAFT—Contract for laying 25 miles of pipe for California Natural Gas Co. has been awarded to Virginia Pipe Line Contracting Company.

TEHAMA—Bonds for $10,000 for construction of municipal water system have been voted.

VAN NUYS—Contract for construction of Marian grammar school has been awarded to J. W. Morrison & Sons, 456 Grand View street, Los Angeles, for $36,868.

WHITTIER—Contract for construction of grammar-school has been awarded to Lepper & Laisy, Builders Exchange, Los Angeles, for $22,740.

WILLIAMS—Lighting district has been formed and lights will be placed at all street intersections.——Recent court decisions will compel West Side Irrigation Co. to build 20 miles of main canal and several laterals.

WOODLAND—A contract for the construction of a smaller school building has been awarded to W. H. Curson and B. Keehn, for $23,953. Robert Trost, 26th and Howard streets, and H. A. Klyce, Sheldon building, both of San Francisco, were the two lowest bidders on the larger building at about $70,000 and their bids were taken under advisement.

YREKA—Bids will be received until 10 a.m., June 7, by W. J. Neilon, county clerk, for construction of the following bridges:

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two reinforced concrete deck bridges over Hudin creek, 30-ft. span each; Pratt truss steel bridge, 80-ft. span over Cottonwood creek; Pratt truss steel bridge, 180-ft. clear span, over Klamath river; two Pratt truss steel bridges, 120-ft. clear span each, over Shasta river; Pratt truss steel bridge, 200-ft. span, over Shasta river. Plans from Harvey J. Sarter, county surveyor.

YUBA CITY—Board of trustees has decided to pave principal streets of city. Whether the necessary funds are to be raised by a bond issue or by direct taxation will be decided at election to be held soon.

OREGON

ASTORIA—Contract for clearing and grading highway between Flavel and Warrenton has been awarded to Ankeny & Scott for $4409.70.

BEND—Shevlin-Hixon Co., Minneapolis, will build large sawmill.

EUGENE—Land-owners in this vicinity will construct system of drainage ditches costing about $20,000. W. L. Benham is interested.

GOLDBEACH—Bids will be received until June 7 by county court for construction of bridge near Port Orchard across Elk river. J. M. Caughell is county surveyor.

NORTH BEND—City council has approved plans for construction of vitrified-pipe sewer-system. Estimated cost $25,300.

PENDLETON—Contract for construction of postoffice has been awarded to James Winters, Couch Bdg., Portland, for $99,500.——Johnson & Mayer, Commercial Club Bdg., Portland, are preparing plans for $25,000 library.

PORTLAND—Thomas Muir, Abington Bdg., has been awarded contract for construction of retaining-wall for Shell Oil Co. This is the beginning of work on its $500,000 distributing station. Reitze & Storey, Northern Bank Bdg., Seattle, Washington, are engineers.——City engineer J. R. Hansen is preparing plans for extension of Greeley street for about two miles. Work will cost about $300,000 and will involve a number of deep cuts.——Marshall-Wells Hardware Co., 5th and Pine streets, will construct concrete addition to warehouse costing $70,000.——Doernbecher Mfg. Co., East 28th street, will erect concrete warehouse costing $50,000.——First Methodist Episcopal church will erect $50,000 building. Tourtellote & Hummel, Rothchilds Bdg., are architects.——Following bids have been received for paving parts of Wistaria Avenue district: Giebisch & Joplin, for asphaltic concrete, $1.06 per sq. yd., for gravel bitulithic, $1.32; Oregon Independent Paving Co., for asphaltic concrete, $1.15; Warren Construction Co., asphaltic concrete, $1.50; Warren Construction Co., gravel bitulithic, $1.50.——Specifications for ten different kinds of pavement for county highway system have been approved. They are brick, wood block, stone block, warrenite, asphaltic concrete, hassam, topeka mixture on asphaltic concrete, and three different types of cement concrete. Bids under these specifications will be called for in a few days. ——Contract for construction of approach on Oregon side of interstate bridge has been awarded to Standard American Dredging Co., 414 13th street, Oakland, Cal., for $112,988.——Contract for repairs to paving on Broadway has been awarded to Oskar Huber, Electric Bdg.——Contract for the construction of a light and fog-signal building at Robinson Point light-station has been awarded to Stebinger Bros. for $4844.——Concrete pavement will be laid on East 71st street costing $13,824——Contract for paving Brooke street has been awarded to Giebisch & Joplin, Rothchilds Bdg., for $13,577.——Bids will be received at U. S. Engineer Office, until 11 a.m., June 7, for furnishing rock for jetty construction at mouth of Columbia river.——J. H. Freedlander, New York, is preparing plans for municipal auditorium.——Contract for repairing drydock has been awarded to J. R. McAllister & Sons, Lewis Bdg., for $35,000.

TILLAMOOK—Contract for construction of Sandlake road has has been awarded to Jeffrey & Bufton, Failing Bdg., Portland, for $5116.

UTAH

CORINNE—Drainage district, comprising 12,000 acres, has been formed in this vicinity. Estimated cost of works is $125,000. G. G. Adney is trustee.

OGDEN—Contract for construction of sidewalks in districts No. 130, 131, 132, and 133 has been awarded to Wheelwright Construction Co., for $11,583. Contract for construction of sidewalks in districts No. 114, 115, and 116 has been awarded to J. P. O'Neill Construction Co., for $16,465.——Concrete reservoir will be built at municipal wells in Ogden canyon. Washington Jenkins is city engineer.——Six-inch water mains will be laid on Poplar avenue.——Contract for construction of concrete dam for Davis & Weber Counties Canal Co. has been awarded to Utah Construction Co. for about $115,000.——City engineer Washington Jenkins has estimated cost of proposed river boulevard to be $110,880.——Contract for construction of $10,000 club-house for Ogden Country Club has been awarded to J. F. Newton & Sons.

PROVO—Bids will be received at office of U. S. Reclamation Service, until 2 p.m., June 16, for construction involving 25,000 cu. yd. canal excavation, and 2600 cu. yd. reinforced concrete. Work is near Payson City, on the San Pedro, Los Angeles & Salt Lake railroad, and the Tintic branch of the Denver & Rio Grande railroad. Particulars from the U. S. Reclamation Service, Provo, or Washington, D. C.——Contract for 6½ miles of extension of Salt Lake & Utah railway has been awarded to William Smith, Salt Lake City.

SALT LAKE CITY—G. R. Bothwell and others have petitioned city commissioners to appropriate $35,000 for extension of surplus canal from Williams lake to Great Salt lake.——Following bids have been received for construction of dam for Twin Lakes reservoir. James Stewart Co., for rubble-concrete dam, $70,485 with time limit 170 days; Stewart Engineering Co., New York, for rubble-concrete dam, $74,996.51, time limit, 170 days; Ryberg Bros. for reinforced-concrete dam, $74,681.25, time limit, 175 days.

WASHINGTON

ANACORTES—Contract for two-course concrete pavement on South Commercial avenue has been awarded to Washington Paving Co., Savage-Scofield building, Tacoma, for $23,777.

CONCRETE—Contract for paving West Main street has been awarded to Skagit Construction Co., Mt. Vernon, for $10,512.10.

DAVENPORT—Contract for construction of road to Reardon has been assigned to Spokane Asphalt & Paving Co., Spokane.

EATONVILLE—Contract for construction of school building has been awarded to Martin & Dugan, 627 Northern Bank building, Seattle, for $21,230.

ELLENSBURG—W. A. Kraner & Co., Chamber of Commerce building, Portland, Oregon, were low bidders at $55,479, for construction of municipal lighting plant.

EPHRATA—Contract for construction of permanent highway No. 7 has been awarded to W. G. Milligan & Co., Spokane, for $14,498.

EVERETT—Contract for construction of Arlington-Granite Falls road has been awarded to M. H. Roose for $5799.——Contract for construction of Marysville bridge has been awarded to G. B. Clarke for $744.——Contract for construction of permanent highway No. 13 has been awarded to Ward & Templeton for $3748.——Contract for construction of frame trestle No. 252 has been awarded to Ward & Templeton for $1250.——Contract for improvement of Everett avenue has been awarded to Washington Paving Co., Savage-Scofield building, Tacoma, for $38,884.19.——Contract for construction of commercial school building has been awarded to Everett Construction Co., for $35,944.——Weyerhauser Timber Co. will construct addition to present sawmill.

GARFIELD—Council has decided upon grading, concrete curbs, and sidewalk on California street.

KALAMA—Contract for construction of Mosquito Creek road has been awarded to Nicholson & Carlson, for $6483.96.

KENT—Contract for construction of water system has been awarded to N. G. Barnes for $5980.

KIRKLAND—Contract for construction of waterworks system has been awarded to J. Erickson, 5812 Woodlawn avenue, for $4995.

MONTESANO—Contract for construction of Wynooche-Wishkah road has been awarded to A. Wallin, Aberdeen, for $515.88. ——Contract for construction of Ocosta road has been awarded to John Grossman, Ocosta, for $2315.13.——Contract for construction of Laidlaw-Cohasset road has been awarded to M. D. Hogan, Hoquiam, for $5765.40.

MORTON—Plant of Morton Electric Co. has been sold to C. O. Smith, Pe Ell, who will make additions to plant.

MT. VERNON—Contract for paving Division and Walla streets has been awarded to M. E. Norris, Burlington.——Contract for construction of 7th avenue sewer has been awarded to Nels Erickson for $1405.——County Commissioners will receive bids until 2 p.m., June 8, for construction of 2½ miles of Monteborne-McMurray road, involving 25,000 cu. yd. excavation.

NEWPORT—County commissioners are receiving bids for construction of court-house, costing $27,000.

NORTH YAKIMA—Contract for construction of permanent highway No. 14 has been awarded to Cascade Construction Co., Central building, Seattle, for $12,962.

OLYMPIA—Contract for construction of Perry Creek bridge has been awarded to Coast Bridge Co., Railway Exchange building, Portland, for $8400.——Contract for paving in South Main street and Maple Park improvement district has been awarded to Independent Asphalt Paving Co., Northern Bank Bdg., Seattle, for $50,176 20.——Contract for improvement of 7th St. has been awarded to Laughman & Son for $1522.40. Contract for improvement to 7th St. has been awarded to William Ganfield.——Bids will be received by State Highway Commission until June 14 for the following highway work: clearing, grading, and draining one mile of highway across Wenas creek; construction of 7½ miles

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of Pacific highway in Clarke county, and construction of 468-ft. steel cantilever bridge over Cowlitz river at Mayfield. Construction of Mayfield bridge will include about 190 tons of steel and 615 cu. yd. concrete. Plans from Commission upon deposit of $2 for each set.——Contract for gravel surfacing three miles of road from Blaine has been awarded to Wothern & Satterthwaite, Linden, for $6444.60. Contract for crushed-rock surfacing three miles of road from Kalama has been awarded to Porter & Conley, Portland, for $11,576. Contract for crushed rock on two miles of road from Carrollton has been awarded to Montague, O'Reilly Co., Blake-McFall building, Portland, for $5060.

PORT ORCHARD—Contract for street improvements has been awarded to L. L. Lent, Bremerton, for $3932.

ROSLYN—Bonds for $20,000 for construction of water system have been voted. G. T. Wake is city clerk.

SEATTLE—Bids will be received until 10 a.m., June 14, for grading and graveling 8 miles of road between Renton and Issaquah. Estimated cost $65,000.——Contract for boilers for municipal electric light plant has been awarded to Charles C. Moore & Co., San Francisco, for $18,475.——Contract for grading and paving on Admiral way has been awarded to Independence Asphalt Paving Co., Northern Bank building, for $230,358.41. ——Contract for paving Brooklyn avenue has been awarded to Washington Paving Co., Scofield building, Tacoma, for $50,560.21.——Contract for concrete curbs and other improvements on 37th avenue has been awarded to L. Coluccio, 1642 Lane street, for $10,771.98.——County commissioners have decided to make additions to new court-house, costing $45,000. Puget Sound Bridge & Dredging Co., Central building, has general contract.——Contract for construction of Auburn-Enumclaw road has been awarded to McGuire Bros., 523 First avenue, for $6143.72.——Bids will be received at U. S. Depot Quartermaster's office, Arcade building, until 9 a.m., June 10, for furnishing 12,000 bbl. cement at Seattle and Honolulu.——Bids are being received by C. E. Dole, purchasing officer, Alaska Engineering Commission, L. C. Smith building, for structural steel for bridge over Eagle Gorge, Alaska.——County commissioners will receive bids until 10 a.m., June 8, for construction of Landsberg bridge. Plans from commissioners upon deposit of $5.——Contract for constructon of sewers on Leary avenue has been awarded to Benjamin, Hawkey & Gartner, 3433 36th avenue, for $18,974.——Contract for furnishing galvanized-iron pipe has been awarded to Seattle Hardware Co., 501 First avenue, for $1701.92.——Contract for construction of Renton Junction-Orillia road has been awarded to Washington Paving Co., Savage-Scofield building.——Contract for construction of Redmond-Snoqualmie road has been awarded to S. Normile, Lowman building, for $43,400.——Contract for repairs to steamer 'Epsom' has been awarded to Seattle Construction & Drydock Co. for $4000.—Bids are being received by Stephen & Stephen, New York block, for construction of brick and concrete school building at Fall City. Estimated cost $35,000.——Contract for construction of $25,000 reinforced-concrete garage for O. L. Willett has been awarded to Warrack Construction Co., Downs block.——Contract for construction of light and power system for fruit storage building has been awarded to Rainier Electric Co., 208 Columbia street, for $3543.——County Commissioners will receive bids until 10 a.m., June 7, for furnishing 200,000 bbl. cement. This cement will be used by King county, Pierce county, city of Tacoma, Seattle port commission.——G. A. Collins, 4139 West Prentice street, will erect $20,000 plant to supply Vashon and Maury islands with electric light and power.——Contract for paving Queen Anne boulevard has been awarded to Independent Asphalt Paving Co., Northern Bank building, for $1.20 per sq. yd.——Contract for construction of skating rink, costing $100,000, has been awarded to Franklin Engineering Co., Hoge building.——Contract for construction of shearleg derrick for port commission has been awarded to Westerman Iron Works, West Lander and Whatcom avenues, for $7100.——Contract for furnishing wire rope for derrick has been awarded to Broderick & Bascom, 623 Western avenue, for $907.82.——Contract for construction of reinforced-concrete Coliseum theatre has been awarded to Pearson Construction Co., New York block, for $141,400.

SOUTH BEND—Contract for construction of permanent highway No. 1A, from East Raymond to Giesey's Crossing, has been awarded to Allred & James, Centralia, for $23,600.

SPOKANE—F. K. McBroom, commissioner of public works, has reported in favor of concrete arch at south end of Monroe Street bridge, steel and concrete bridge at Howard street, and surfacing Division Street bridge. Estimated cost of these improvements about $60,000, which it is proposed to raise by bond issue.——Contract for making sewer changes on Sprague and First avenues and on Division street has been awarded to W. J. Hoy & Co. for $25,000.——Contract for construction of Catholic church has been awarded to Alloway & George for $28,000.——Council is considering improvement of Grand avenue, costing $25,000. Morton Macartney is city engineer.

TACOMA—City engineer Raleigh is preparing plans for 650-ft. wooden bridge at 34th street, costing $14,000.——Heath & Gove, National Realty building, are preparing plans for arsenal near Cosgrove, to cost $20,000.——Contract for resurfacing 12½ miles of county road has been awarded to Oregon Road Oiling Co., Couch building, Portland, for 4¼c. per sq. yd.——Contract for construction of 7 miles of railroad near Tenino has been awarded to Dibble-Hawthorne Co. for $50,000.——Contract for planking on Railroad avenue has been awarded to B. S. Davis for $3643.

TENINO—Contract for furnishing rock for Columbia River jetty has been awarded to Hercules Sandstone Co., for $1.50 per ton.

TOPPENISH—Contract for addition to city water system has been awarded to Edward Taylor for $1950.

WALLA WALLA—Contract for bitulithic pavement on South Palouse street has been awarded to Warren Construction Co., Portland, for $18,720.——Contract for construction of bitulithic concrete pavement on 9th street and on Isaacs avenue, has been awarded to H. L. Wilson Co., for 98c. per sq. yd.——Contract for paving South Second street has been awarded to Warren Construction Co., Portland, for $5100.——Contract for paving Whitman street with 2-in. bituminous top on 4-in. concrete base has been awarded to H. L. Wilson & Co., for $18,924. ——M. J. Hursen & Co., Globe block, Seattle, was low bidder at $137,750 for construction of courthouse.——Contract for construction of roundhouse for Oregon-Washington Railway & Navigation Co., has been awarded to Moore Bros., 406 East 37th street, Portland.

Engineering Societies and Conventions

Los Angeles Section of AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Ford W. Harris, secretary, 1029 Higgins building.

Southern California Association of Members, AMERICAN SOCIETY OF CIVIL ENGINEERS. W. K. Barnard, secretary, 701-2 Central building, Los Angeles.

Los Angeles Section, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Edward Woodbury, secretary, 255 East 3rd street.

IDAHO SOCIETY OF ENGINEERS. Ira F. Shaffner, secretary, Boise.

Portland Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. Charles McGonigle, president, care Western Sheel Metal Works.

Portland Section, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Paul Lebenbaum, secretary, 45 Union Depot.

San Francisco Association of Members of the AMERICAN SOCIETY OF CIVIL ENGINEERS. E. T. Thurston, Jr., secretary, Mechanics Institute building.

San Francisco Section of the AMERICAN SOCIETY OF MECHANICAL ENGINEERS. F. W. Gay, secretary, care J. G. White & Co., Alaska Commercial building.

Coming Conventions

NATIONAL ELECTRIC LIGHT ASSOCIATION, San Francisco, June 8-11, inclusive.

TRI-STATE GOOD ROADS ASSOCIATION, San Francisco, August 2 and 3.

PACIFIC HIGHWAY ASSOCIATION OF NORTH AMERICA, San Francisco, August 11 and 12.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, San Francisco, August 25-28.

LEAGUE OF CALIFORNIA MUNICIPALITIES, Oakland, September 7-11.

INTERNATIONAL IRRIGATION CONGRESS, Stockton, September 13-14; Fresno, September 15-16; Sacramento, September 17-18; San Francisco, September 20.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, San Francisco, September 16-17.

AMERICAN INSTITUTE OF MINING ENGINEERS, San Francisco, September 16-17.

AMERICAN ELECTROCHEMICAL SOCIETY, San Francisco, September 16-18.

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AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, San Francisco, September 16-18.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, San Francisco, September 16-18.

AMERICAN SOCIETY OF CIVIL ENGINEERS, San Francisco, September 16-18.

AMERICAN MINING CONGRESS, San Francisco, September 20-22.

INTERNATIONAL ENGINEERING CONGRESS, San Francisco, September 20-25.

PAN-AMERICAN ROAD CONGRESS, Oakland and San Francisco, September 13-18.

Personal

GEORGE CROMWELL has been appointed city engineer of San Diego.

C. E. ARNOLD has been appointed city engineer of Woodland, California.

C. C. BONEBRAKE has been re-appointed city engineer of Santa Ana, California.

JOHN OAKEY has been appointed city engineer of San Bernardino, California.

CHARLES A. MILLER has been appointed city engineer of Oregon City, Oregon.

EUGENE M. BOOTH, of Lewiston, has been appointed state highway engineer of Idaho.

R. H. THOMSON has opened offices as a consulting engineer at 520 Alaska building, Seattle.

BERTRAM D. DEAN has opened an office as consulting engineer at 2110 L. C. Smith building, Seattle.

CHARLES EVAN FOWLER, of Seattle, has completed plans for the Simpson Avenue bridge at Hoquiam, Washington.

R. W. FLETCHER, for some time engineer of Winlock, Washington, has been appointed city engineer of Vader, Washington.

FRED M. LOCKWOOD has been appointed city manager of San Diego. Mr. Lockwood has held various engineering positions under the city for the past seven years.

HERBERT NUNN has been appointed engineer in charge of permanent highway work in Multnomah county, Oregon, under the recently-voted $1,250,000 bond issue.

At the quarterly meeting of the Idaho Society of Engineers held May 15 at the Boise Commercial Club, JOHN P. CONGDON spoke on 'Costs of Sewer Work in Pocatello.'

ELWOOD MEAD, chief engineer of the state river and harbor commission of Victoria, Australia, has been appointed professor of rural institutions at the University of California.

J. F. LUCEY, the California oil-well supply man who has been in Belgium for several months in connection with the work of the American relief committee, has returned to California.

W. R. ECKART, of the department of mechanical engineering at Stanford University, has been chosen to represent the Institute of Mechanical Engineers of London at the International Engineering Congress.

FRANK R. WHEELER has taken a position with the Green Engineering Co., Pittsburgh, Pennsylvania. His position as district manager for the Kerr Turbine Co., with headquarters at San Francisco, has been taken by L. F. HALLORAN.

At the regular meeting of the Los Angeles Section of the American Institute of Electrical Engineers held in the Chamber of Commerce building, May 18, GEORGE L. HEDGES addressed the section on 'Solenoid and Electromagnet Windings.'

At the regular meeting of the Portland Association of Members of the American Society of Civil Engineers, held May 18, J. P. NEWELL delivered an address on the 'Valuation of Water-Power Rights of the Portland Railway, Light & Power Company.'

CHARLES P. LIGHT, field secretary for the American Highway Association, has been 'loaned' by the directors of that organization to the Pan-American Road Congress, until the close of the meeting of the Congress in September, in Oakland, California.

C. E. LESHER, associate geologist of the land-classification board of the United States Geological Survey, has been assigned to take charge of the work of compiling the statistics of coal production published in the annual volume on 'Mineral Resources.'

PAUL WHITHAM, of Seattle, has been called to New York and Cleveland in a consulting capacity with regard to warehouse and water-front terminal problems. While in the East he will make a study of plans for industrial development on behalf of the Seattle Chamber of Commerce.

FREDERICK H. NEWELL has been appointed head of the department of civil engineering at the University of Illinois. Mr. Newell was for twenty-six years in various branches of the government service, principally as chief engineer and later as director of the United States Reclamation Service.

A. E. CAMPBELL, of San Luis Obispo, who has been acting as Federal receiver of the oil lands involved in certain suits brought by the Government, has resigned to take the position of special assistant to United States Attorney-General E. W. GREGORY. He will be engaged in the prosecution of the Government's oil suits in California. His place as receiver will be taken by H. M. PAYNE, of San Luis Obispo.

Obituary

F. S. EDINGER, of Berkeley, of the contracting firm of Shattuck & Edinger, died suddenly in Stockton on May 18.

EDWARD T. MORRIS, manager and construction engineer for the Associated Pipe Line Co., died in Oakland, California, on May 14. He was connected with the Union Iron Works for a number of years and superintended the construction of the battleship *Oregon* and many other vessels.

Commercial Paragraphs

The KOEHRING MACHINE CO. has opened branch offices at 326 Pittock building, Portland.

The BROWNING COMPANY has sold a $6000 locomotive crane to the Alaska Railroad Commission.

The ENGINEERING & FOUNDRY CO., recently incorporated at Stockton, California, has commenced the erection of a foundry and machine shop. Besides doing a general machine shop and foundry business, the company expects to make gas-engines.

CHALMERS & WILLIAMS report the sale of a 5 by 12-ft. adjustable quick-discharge tube-mill to Balfour-Williamson & Co. for shipment to India, and the sale of a 36-in. Symons disc-crusher to the White Oak Crushed Stone Co., Plainville, Connecticut.

The HERCULES POWDER CO. will install an auxiliary fire-protection system at its plant at Hercules, California. E. A. Keithley, Rialto building, San Francisco, representing the Central Foundry Co. of New York, has secured an order from the Hercules company for 9000 lin. ft. of 6-in. Universal pipe in connection with this work.

The INGERSOLL-RAND CO., which has for a number of years been represented on the Pacific Coast by Harron, Rickard & McCone, will, upon the expiration of their present contract on July 22 next, open a branch office of their own at 139 Townsend street, San Francisco. H. R. Terwilliger, president of Harron, Rickard & McCone, will resign to become district manager of the Ingersoll-Rand Co., and H. G. Mitchell will succeed him.

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